1980

Groundwater Levels in Nebraska, 1979

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Conservation and Survey Division

Nebraska Water Survey Paper Number 50

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Conservation and Survey Division
Institute of Agriculture and Natural Resources
The University of Nebraska — Lincoln

The Conservation and Survey Division of the University of Nebraska is the agency designated by statute to investigate and interpret the geologically related natural resources of the state, to make available to the public the results of these investigations, and to assist in the development and conservation of these resources.

The division is authorized to enter into agreements with federal agencies to engage in cooperative surveys and investigations in the state. Publications of the division and the cooperating agencies are available from the Conservation and Survey Division, University of Nebraska, Lincoln, Nebraska 68588.

Publication and price lists are furnished upon request.

July 1980

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York recorder well 21

FACTORS FOR CONVERTING ENGLISH UNITS
TO THE INTERNATIONAL SYSTEM OF UNITS (SI)

Multiply English units	By	To obtain SI units
	Length	
inches (in)	25.4	millimeters (mm)
feet or foot (ft)	.3048	meters (m)
miles (mi)	1.609	kilometers (km)
	Area	
acres	4047	square meters (m^2)
square miles (mi^2)	2.590	square kilometers (km^2)
	Volume	
acre-feet (acre-ft)	1233	cubic meters (m^3)
	Flow	
gallons per minute (gpm)	.00006309	cubic meters per second (m^3/s)

This report on Nebraska's groundwater levels summarizes the water-level changes in 1979 on a statewide basis and by major areas.

INTRODUCTION

In 1930, the Conservation and Survey Division of the University of Nebraska and the U.S. Geological Survey began a cooperative water-level measurement program to observe and document on a continuing basis the fluctuations in groundwater levels throughout Nebraska.

This report, the twenty-sixth annual report on Nebraska's groundwater levels, summarizes the water-level changes in 1979 on a statewide basis and by major areas where significant changes from estimated predevelopment levels have occurred. It describes the availability of data on water levels, provides information on changes in the water-level measurement program during the year, and summarizes data on the two major causes of water-level changes—precipitation and groundwater use. Because of the large amount of available data, much of the information presented in this report is of a generalized nature. The maps showing areas where water levels have risen or declined are an interpretation of point-value data, and some areas may not be precisely delineated.

The primary objective of any water-level measurement program is to monitor groundwater-level fluctuations and to detect significant water-level changes in wells. For maximum effectiveness, a water-level measurement program should also include evaluation of the adequacy and accuracy of collected water-level information and provide a means for its storage, retrieval, and dissemination in a readily understandable format.

Important among the uses of data on groundwater levels in Nebraska are the following:

1. To determine the amount of groundwater in storage and the availability of supplies.
2. To assess the water-supply outlook by determining changes in the amount of groundwater in storage.
3. To identify areas where rising groundwater levels might cause waterlogging and areas where water levels are declining toward limits of economic groundwater use.
4. To provide long-term records useful for evaluating the effectiveness of land-management and water-conservation programs, for correlating and evaluating the shorter records from project studies, and for assessing the validity of the project findings.
5. To provide data for use in estimating or determining rate and direction of groundwater movement, water loss by evapotranspiration, specific yield of aquifers, base flow of streams, sources and amounts of recharge, and locations and amounts of discharge.
6. To supply long-term records needed for testing hydrologic simulation models and for assessing the validity of model assumptions and approximations.

Nebraska's water-level measurement program includes the collection of many more data than are presented in this report. These additional data are available, upon request, from the Conservation and Survey Division.

Water levels rose in about two-thirds of Nebraska's observation wells in 1979.

CHANGES IN WATER LEVELS, 1979

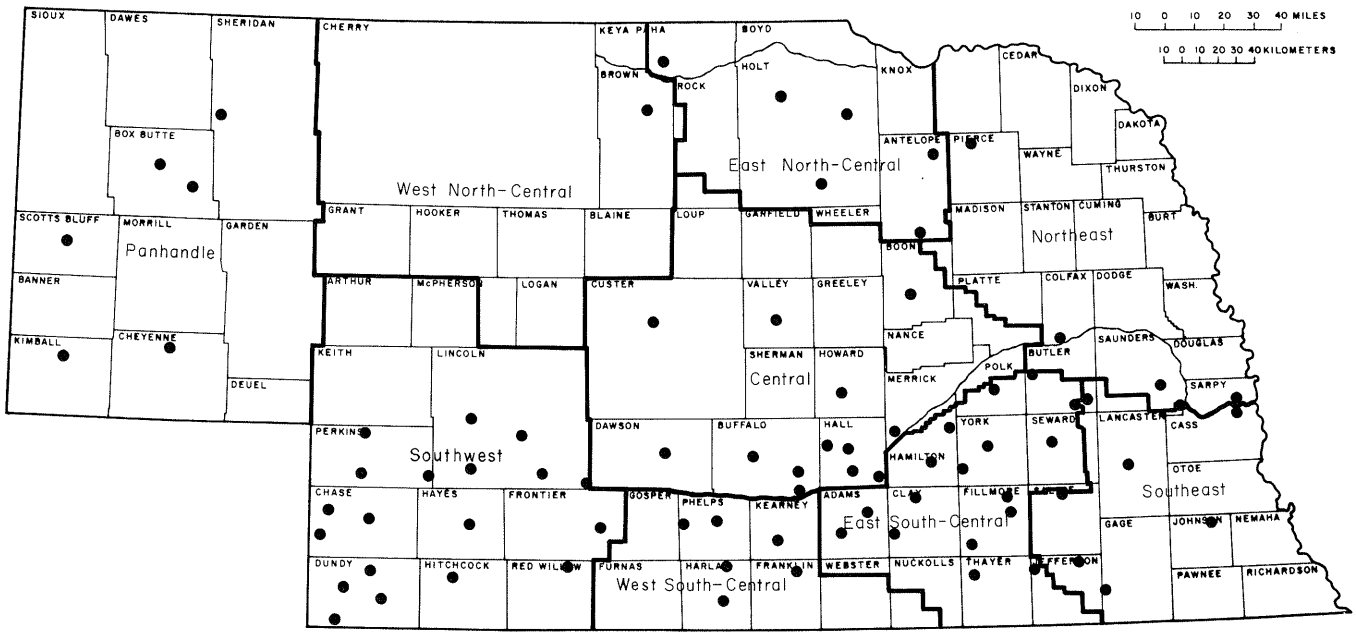
Water levels in Nebraska were higher in fall 1979 than in fall 1978 in 65 percent of the observation wells measured. Levels were generally less than 2 ft (0.61 m) higher, although rises of 4 ft (1.22 m) or more occurred locally in several areas of the state. Following the irrigation season, many wells that had shown progressive long-term declines in water levels recovered to near or higher than fall 1978 levels. The only large area in which water levels continued to decline was in Chase and Dundy counties, where intensive development of groundwater for irrigation has taken place. Water levels mostly declined in this area but at a lesser rate than in recent years.

Comparison of fall 1979 water levels with estimated predevelopment water levels allowed delineation of most areas where development of groundwater resources has resulted in significant declines or rises in water levels. Water-level data collected by Natural Resources Districts in 1979 permitted the delineation of some areas of water-level changes that otherwise might not have been detected. Data are sufficient to describe the water-level rises and declines that have occurred in most areas of the state. To facilitate description of water-level changes, the state has been subdividied into the following nine parts, each of which is described separately: Southeast Division, Northeast Division, East South-Central Division, West South-Central Division, Central Division, East North-Central Division, Southwest Division, West North-Central Division, and Panhandle Division. Hydrographs of recorder wells located within the divisions are included in each section to illustrate the seasonal and long-term fluctuations that have occurred in water levels at different locations in the division.

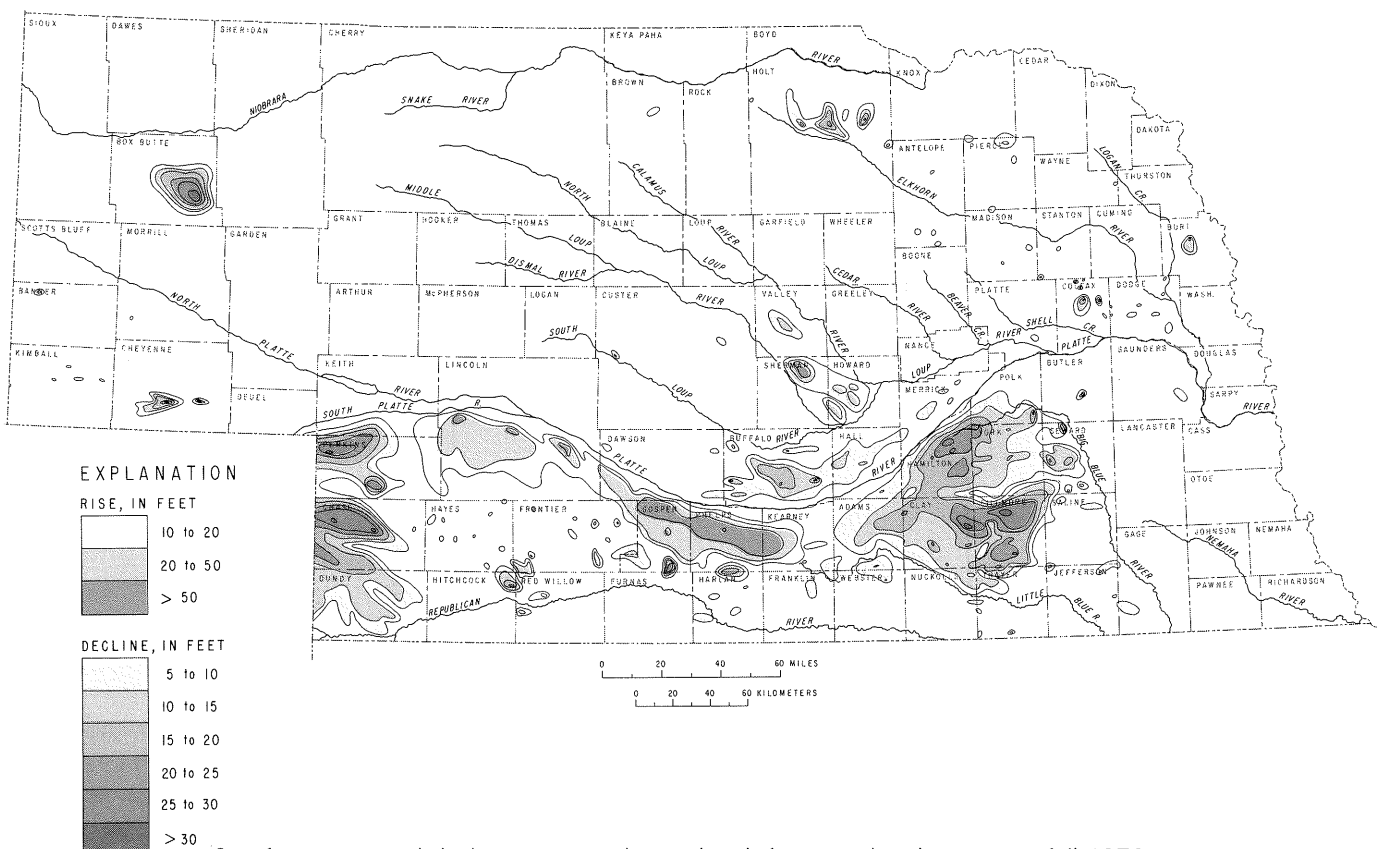
The period of record for many observation wells is too short to provide a satisfactory basis for determining long-term water-level changes. Where possible, an individual comparision is made between the 1979 water level and the estimated predevelopment water level. The estimated predevelopment water level is the approximate average water level existing in a well prior to any man-made development that significantly affected water levels in the vicinity of the well. All available water-level data collected prior to or during the early stages of development are used to estimate the predevelopment water levels.

Before development by man, most groundwater systems are in a state of equilibrium—that is, long-term recharge is approximately equal to long-term discharge. In Nebraska, this natural equilibrium of groundwater systems has been altered by: (1) increased discharge from irrigation wells, (2) recharge from infiltration of surface water applied to irrigated crops or from deep percolation of seepage from the irrigation storage and distribution systems, (3) discharge to man-made drains, and (4) changes in land use that affect the amount of recharge an aquifer receives. In many parts of the state, water-level fluctuations resulting from natural conditions may be either masked or accentuated by water-level fluctuations resulting from man's activities. Judgment must be exercised, therefore, when evaluating the significance of water-level data.

The significance of any measured water level is dependent upon the many factors that cause water-level fluctuations. In Nebraska, where use of water for irrigation causes the most significant water-level fluctuations, most observation wells are measured in the spring and in the late fall. Measurements made in the spring are useful in determining amounts of groundwater in storage before irrigation starts each year. Measurements made in the fall are useful in evaluating the effects of annual water use for irrigation and for delineating more accurately problem areas or potential problem areas. The extent and magnitude of water-level changes generally are somewhat smaller if determined from measurements made in the spring. Therefore, measurements made in the fall are used in this report for documenting both the annual and the long-term water-level changes. In the description of the East South-Central and Southwest divisions, which have groundwater control areas, the changes between estimated predevelopment water levels and spring 1979 levels are shown also.



Location of recorder wells and boundaries of divisions



Significant rises and declines in groundwater levels from predevelopment to fall 1979

Southeast Division

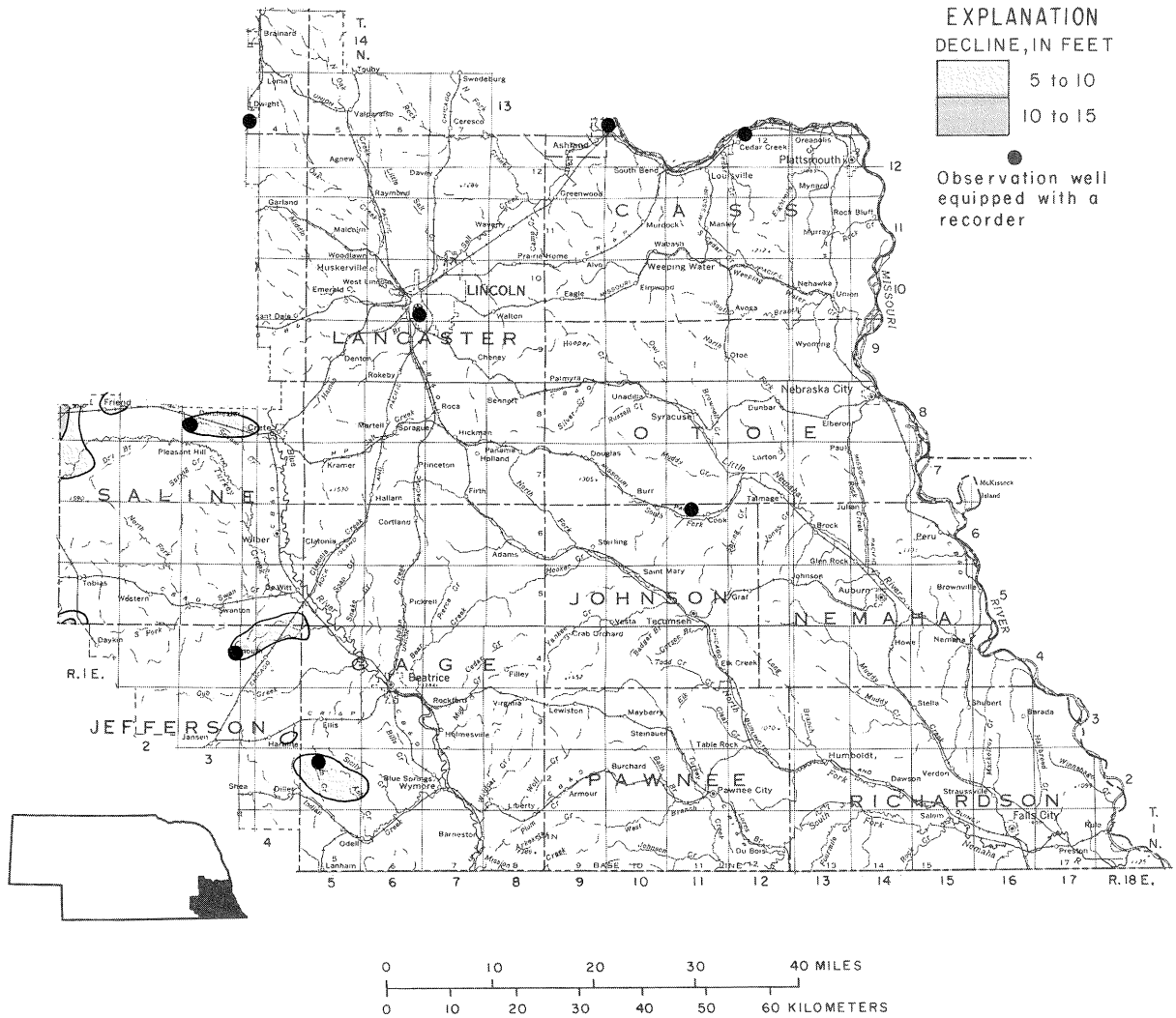
Water levels in southeastern Nebraska were mostly higher in fall 1979 than in fall 1978. Rises averaged slightly less than 1 ft (0.305 m), with the largest rises—up to 3.3 ft (1.01 m)—occurring in western Gage County.

Development of groundwater resources for irrigation has been limited mostly to the western part of the area where declines of a little more than 5 ft (1.52 m) from estimated predevelopment levels have occurred in an area of approximately 58,000 acres (235 km^2). Maximum declines of slightly more than 11 ft (3.35 m) have occurred in wells in western Gage and northeastern Jefferson counties.

Approximate areas of significant water-level declines from estimated predevelopment water levels to fall 1979 were:

Amount of decline, in feet (meters, m)	Approximate area, in acres (square kilometers, km^2)
5.00-10.00 (1.53-3.05)	56,000 (227)
10.00-15.00 (3.05-4.55)	1,780 (7.2)

Estimated predevelopment water levels are based on water levels measured prior to the early 1950s. Data needed to determine predevelopment levels are sufficient only in the western part of the area, but existing water-level measurement programs provide sufficient data for good definition of current water-level changes in nearly all the area.



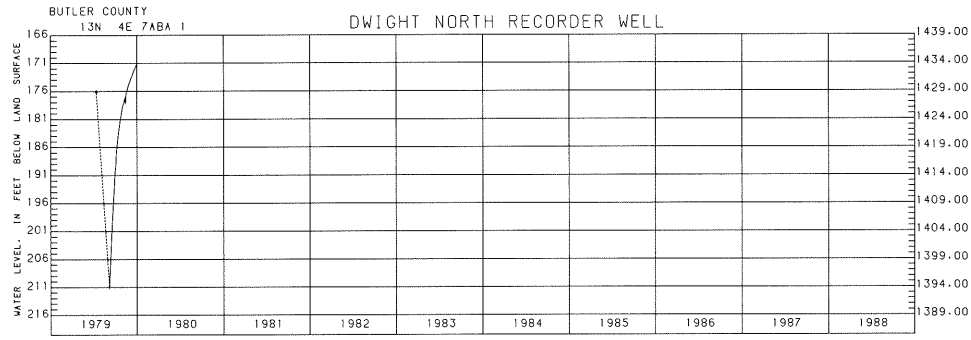
Areas of significant water-level change in the Southeast Division from 1950 to fall 1979

Butler County: Dwight North

Estimated predevelopment water level: Not determined

Net water-level change in 1979: Not determinable

Average annual net water-level change since 1979: Not determinable

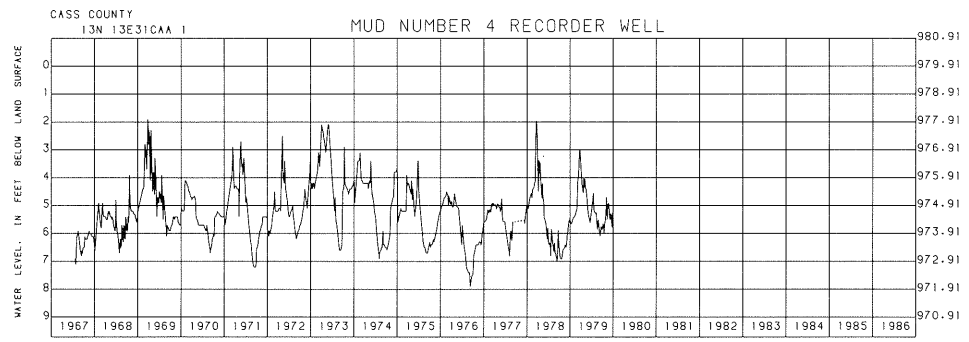


Cass County: MUD No. 4

Estimated predevelopment water level: 4.5 ft (1.37 m)

Net water-level change in 1979: −0.40 ft (−0.122 m)

Average annual net water-level change since 1967: Not significant; no long-term trend

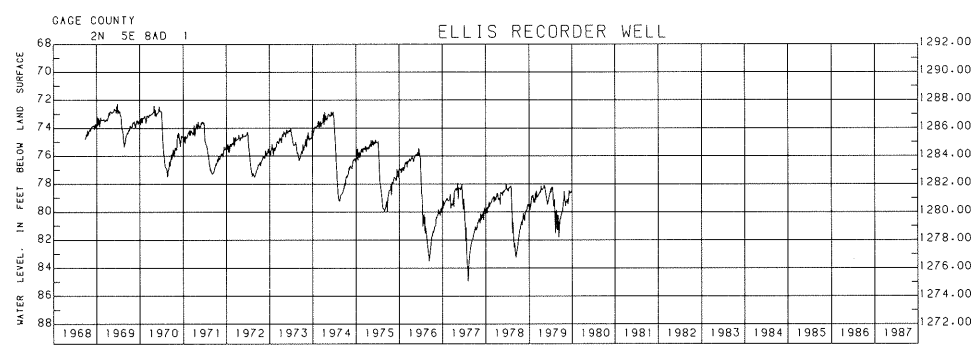


Gage County: Ellis

Estimated predevelopment water level: 73 ft (22.3 m)

Net water-level change in 1979: +1.37 ft (+0.420 m)

Average annual net water-level change since 1968: −0.40 ft (−0.122 m)

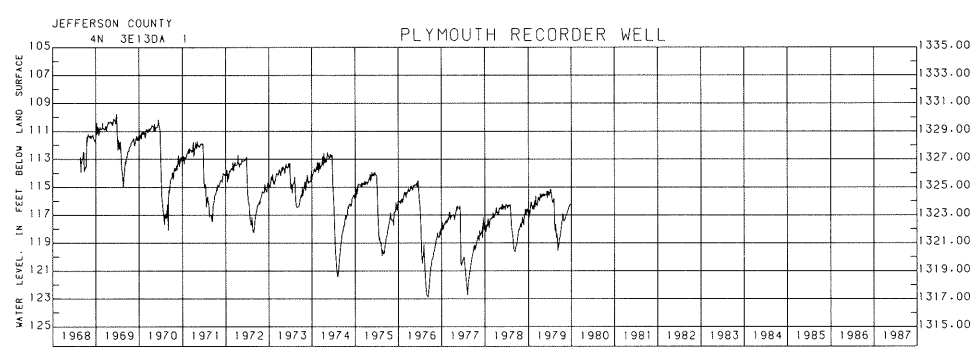


Jefferson County: Plymouth

Estimated predevelopment water level: 107 ft (32.5 m)

Net water-level change in 1979: +0.81 ft (+0.247 m)

Average annual net water-level change since 1968: −0.43 ft (−0.131 m)

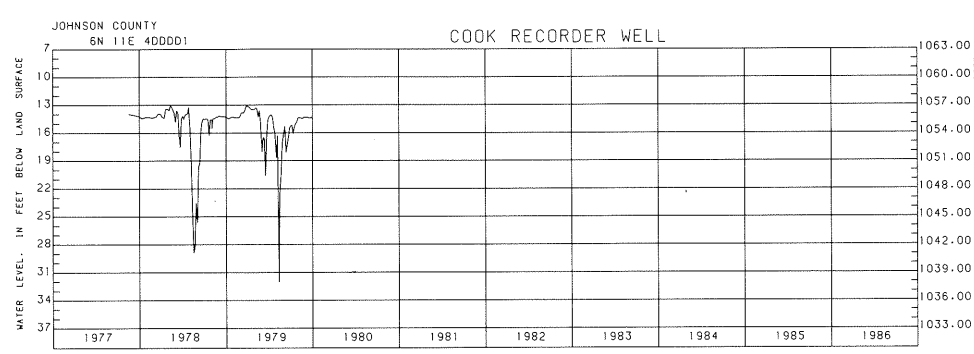


Johnson County: Cook

Estimated predevelopment water level: 13 ft (3.95 m)

Net water-level change in 1979: −0.04 ft (−0.012 2 m)

Average annual net water-level change since 1977: −0.05 ft (−0.015 2 m)

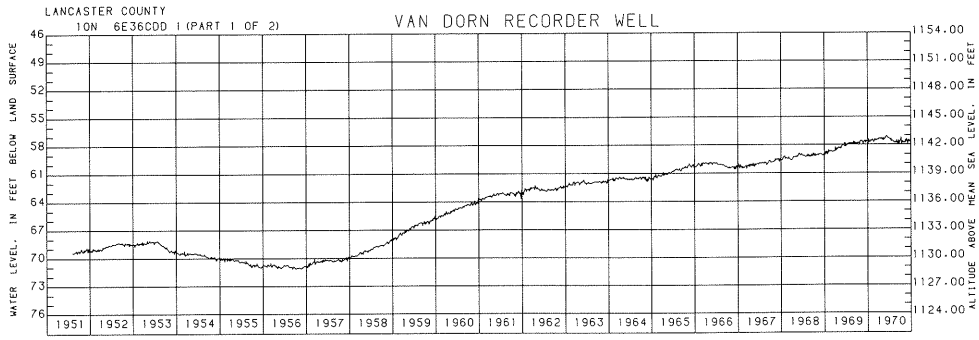


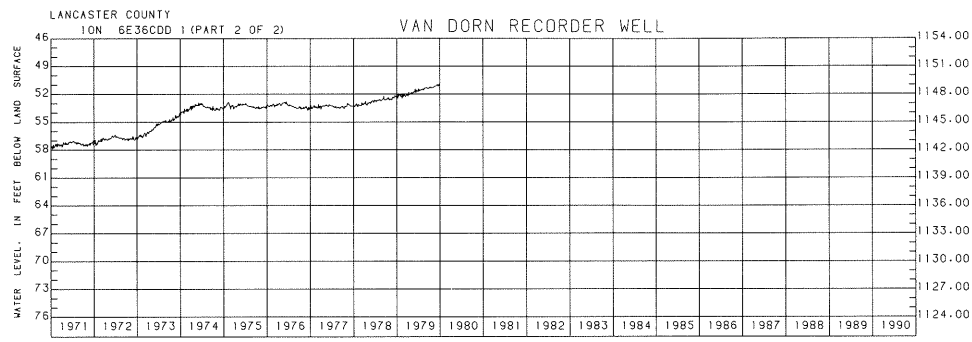
Lancaster County: Van Dorn

Estimated predevelopment water level: 35 ft (10.7 m)

Net water-level change in 1979: +1.40 ft (+0.425 m)

Average annual net water-level change since 1951: +0.65 ft (+0.198 m)



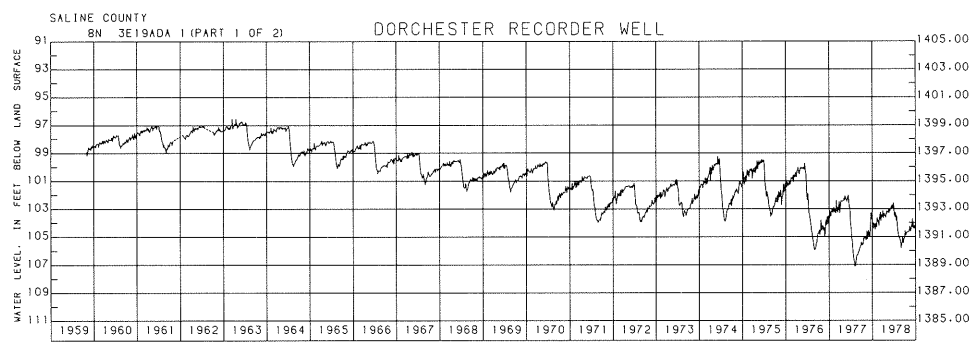


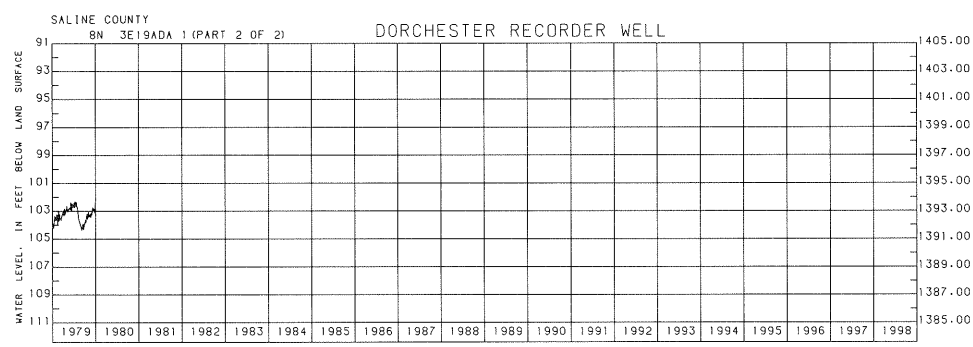
Saline County: Dorchester

Estimated predevelopment water level: 97 ft (29.5 m)

Net water-level change in 1979: +2.09 ft (+0.64 m)

Average annual net water-level change since 1959: −0.18 ft (−0.055 m)





Northeast Division

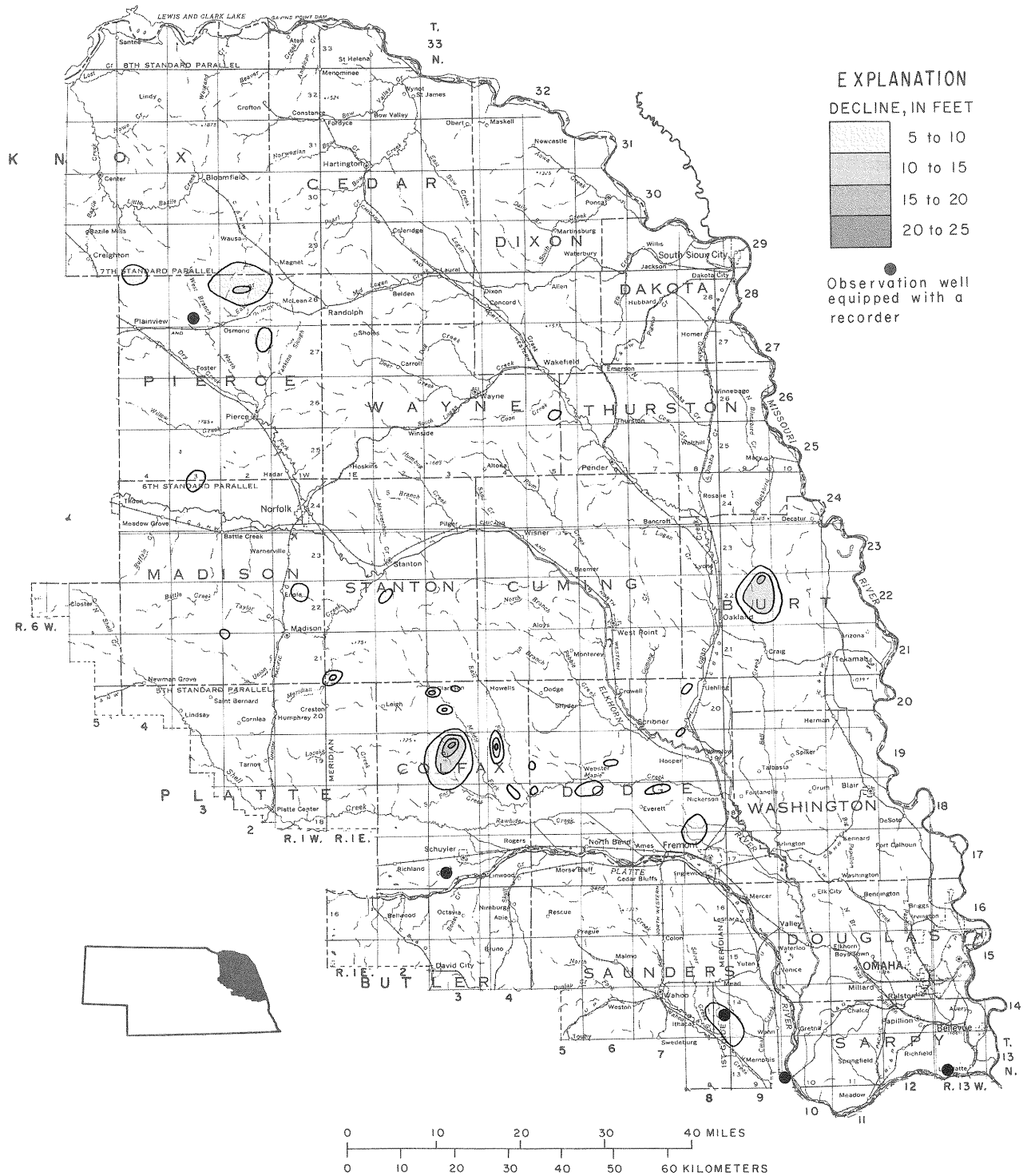
Water levels in about 75 percent of the wells measured in fall 1979 were higher than those measured in fall 1978 in the Northeast Division, which includes the following Natural Resources Districts: Lower Elkhorn, Lewis and Clark, Lower Platte North, Papio, and Middle Missouri Tributaries. Net rises averaged about 1.5 ft (0.455 m), with maximum rises of 8 ft (2.44 m) occurring in two wells in northern Cuming County. The higher water levels resulted in part from normal to above-normal precipitation in the spring and early summer. During this period, recharge to the aquifer was greater than in most years and the water demand for irrigation was less. Where water levels declined, most decreases were less than 1 ft (0.305 m).

Fall 1979 water-level measurements indicate declines of 5.00 ft (1.52 m) or more from estimated predevelopment levels in many areas of the Northeast Division. The areas of decline are generally local in extent and cannot be accurately delineated by means of existing water-level data. The largest decline recorded for fall 1979 was 22.4 ft (6.8 m) in a well in central Colfax County. Water-level declines in this area represent decreases in artesian pressure rather than sizable decreases in groundwater storage.

Groundwater levels in northeastern Nebraska are influenced locally in many places by withdrawals for irrigation. Development of groundwater resources for irrigation began in the 1930s and accelerated in the early 1950s and mid-1970s because of drought conditions during those periods. In the 25-year period from 1954 to 1979, the number of irrigation wells installed and registered increased from 491 to 6,951.

Large water-level declines from estimated predevelopment levels are the result of intensive pumpage during the irrigation season; however, spring water-level measurements show that these declines are mostly seasonal and that the water levels should recover to near estimated predevelopment levels by the following irrigation season in most areas. In 1979, recharge to the groundwater reservoir from snowmelt and spring rainfall was above normal and, in combination with reduced withdrawals for irrigation, resulted in higher water levels following the irrigation season than those of the previous year. Historical data indicate that drought conditions lasting several years could cause long-term declines in water levels by increasing dependence on groundwater for irrigation and reducing recharge to the aquifer.

Sufficient data are available to give reasonably good definition of estimated predevelopment water levels throughout most of this division, while measurements from existing observation wells provide adequate data for definition of current water-level changes.



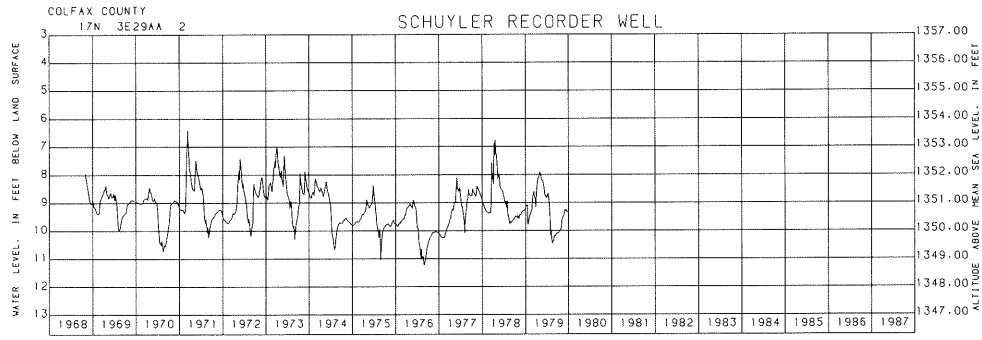
Areas of significant water-level change in the Northeast Division from 1950 to fall 1979

Colfax County: Schuyler

Estimated predevelopment water level: 7.5 ft (2.29 m)

Net water-level change in 1979: −0.19 ft (−0.058 m)

Average annual net water-level change since 1968: −0.04 ft (−0.012 2 m)

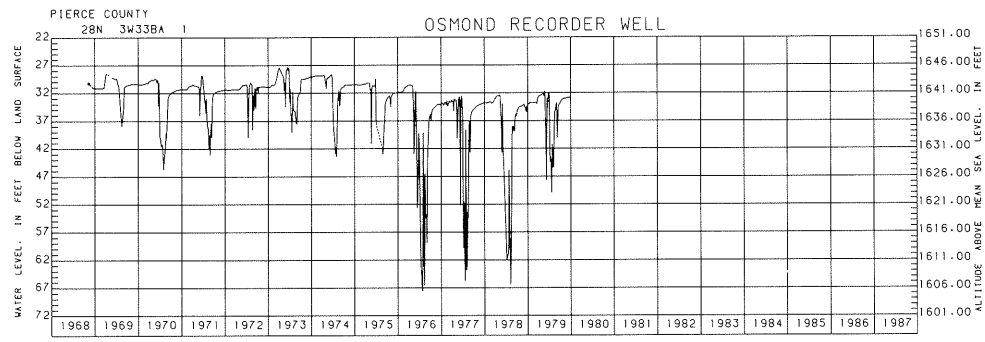


Pierce County: Osmond

Estimated predevelopment water level: 29 ft (8.8 m)

Net water-level change in 1979: +1.22 ft (+0.370 m)

Average annual net water-level change since 1968: −0.04 ft (−0.012 2 m)

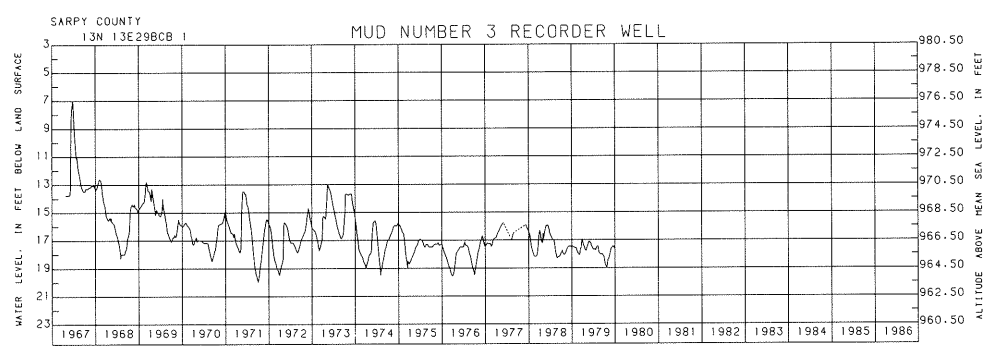


Sarpy County: MUD No. 3

Estimated predevelopment water level: 13 ft (4.00 m)

Net water-level change in 1979: −3.91 ft (−1.19 m)

Average annual net water-level change since 1967: Not significant; no long-term trend



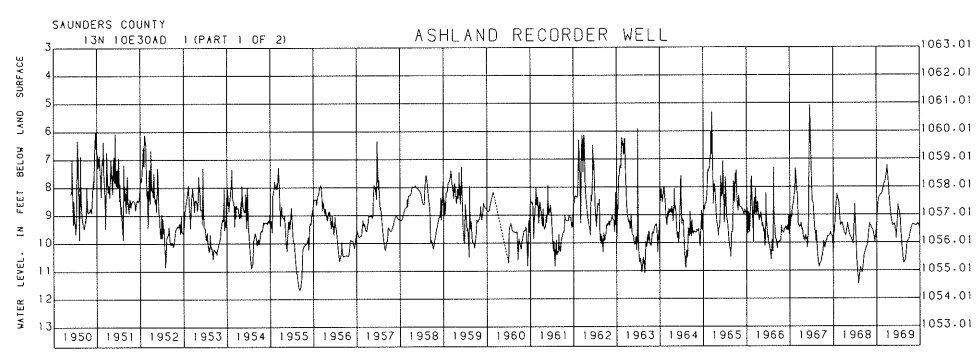
Saunders County: Ashland

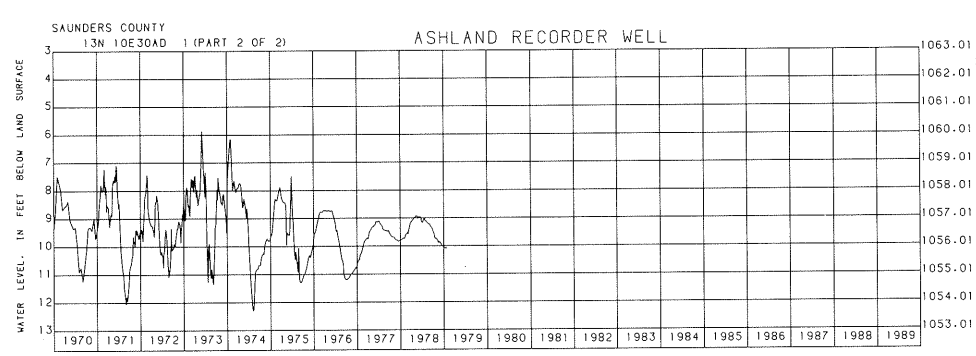
Estimated predevelopment water level: 9 ft (2.75 m)

Net water-level change in 1979: Not determinable

Average annual net water-level change since 1950: Variable; no long-term rising or declining trend

Note: Well collapsed; no record in 1979



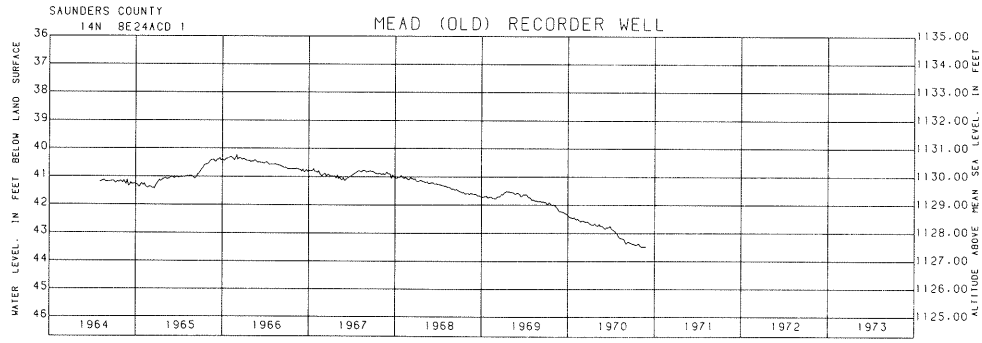


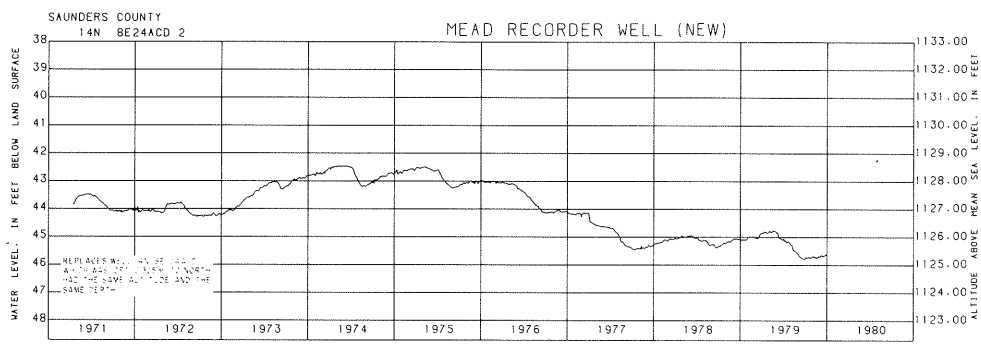
Saunders County: Mead

Estimated predevelopment water level: 40 ft (12.2 m)

Net water-level change in 1979: −0.55 ft (−0.168 m)

Average annual net water-level change since 1964: −0.20 ft (−0.060 m)





Long-term hydrographs of non-recorder wells

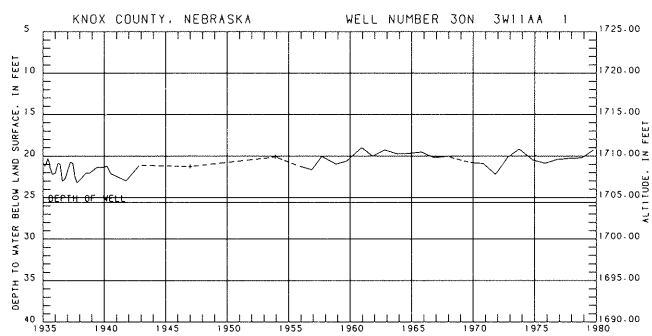
Knox County: 30N 3W 11AA1

Estimated predevelopment water level: 20.0 ft (6.1 m)

Highest water level: 18.99 ft (5.79 m), December 7, 1960

Lowest water level: 23.25 ft (7.09 m), October 9, 1937

Period of record: 1934-79



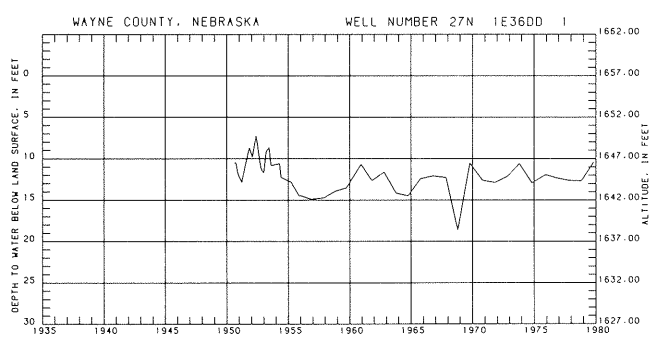
Wayne County: 27N 1E 36DD1

Estimated predevelopment water level: 10.6 ft (3.23 m)

Highest water level: 7.25 ft (2.21 m), May 16, 1952

Lowest water level: 18.63 ft (5.68 m), October 23, 1968

Period of record: 1950-79



East South-Central Division

Water levels in about 70 percent of the East South-Central Division observation wells measured in fall 1979 were higher than those measured in fall 1978. This division, which is made up of the Little Blue Natural Resources District and the Upper Big Blue Natural Resources District, recorded rises of up to 9 ft (2.75 m) in some wells, although the rises averaged 1.7 ft (0.52 m). Water-level declines, for the most part less than 1.0 ft (0.305 m), occurred in Nuckolls, Thayer, and Fillmore counties.

Pumping for irrigation during the past 30 years caused water levels to decline slightly more than 5 ft (1.52 m) below estimated predevelopment levels in an area of approximately 1.98 million acres (8 000 km²). Maximum long-term declines of approximately 50 ft (15.2 m) occurred in a few wells southwest of Fairmont in Fillmore County.

Approximate areas of significant water-level declines from estimated predevelopment water levels in fall 1979 were:

Amount of decline, in feet (meters, m)	Approximate area, in acres (square kilometers, km²)
5.00-10.00 (1.52-3.05)	618,000 (2 500)
10.00-15.00 (3.05-4.55)	669,000 (2 700)
15.00-20.00 (4.55-6.1)	421,000 (1 700)
20.00-25.00 (6.1-7.6)	197,000 (800)
25.00-30.00 (7.6-9.1)	71,000 (290)
30.00 or more (9.1 or more)	8,100 (33)

Sufficient data are available to give good definition of the estimated predevelopment water levels throughout most of the division; in addition, existing observation-well networks provide data for good definition of current water-level changes in most of the area.

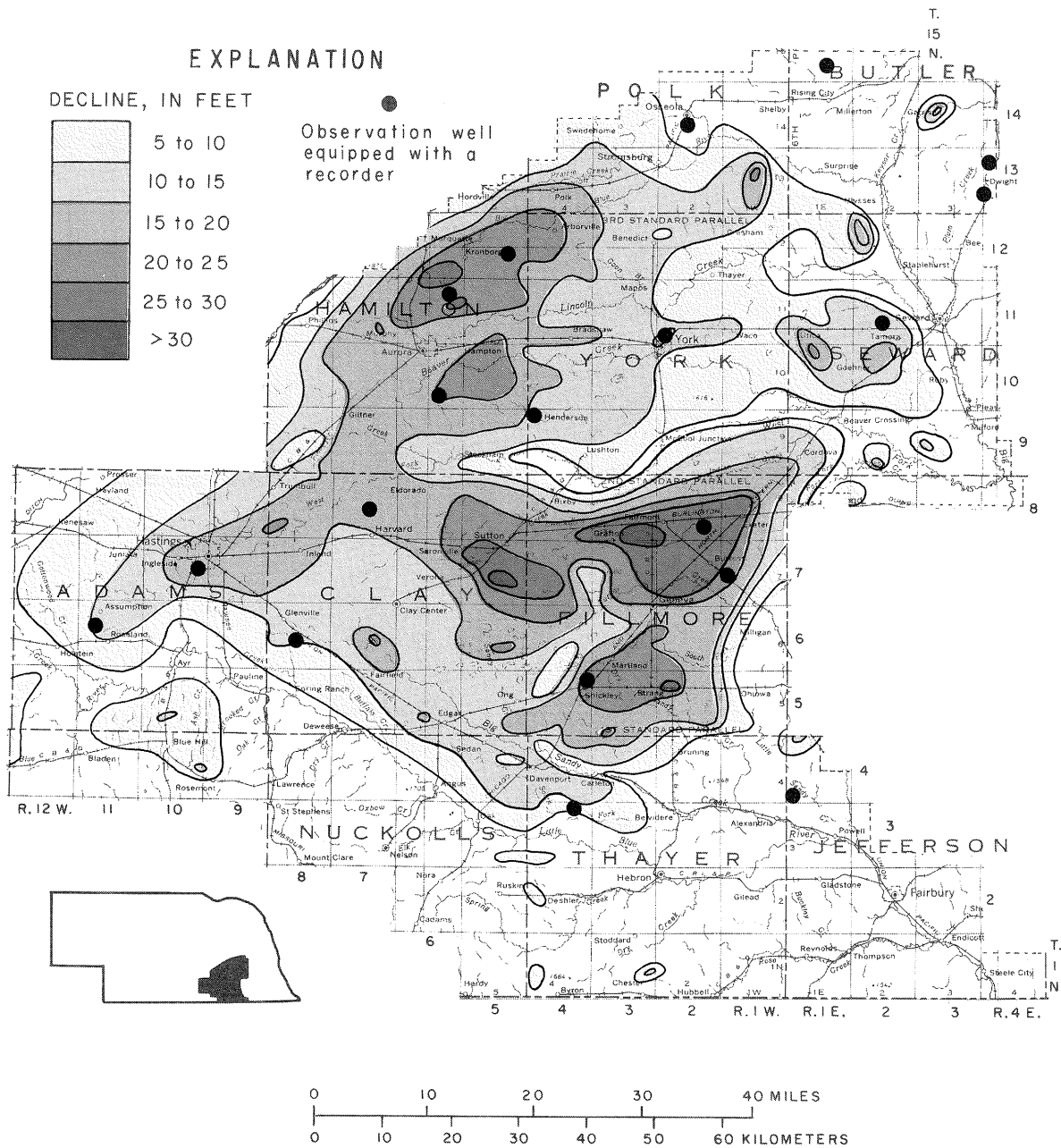
Predevelopment water levels in this division are representative of the mean water levels in the early 1950s. Although about 700 irrigation wells had been drilled prior to 1950, they were mostly scattered. Consequently, significant water-level declines had occurred in only a few small localities. Drought conditions from 1953 to 1956 resulted in such widespread development of groundwater for irrigation that by 1957 approximately 6,400 irrigation wells had been drilled. This intensive groundwater development, coupled with drought conditions, started widespread water-level declines that have continued to the present.

Drought and favorable economic conditions from 1973 to 1976 again resulted in an increase in the number of new irrigation wells installed annually and in a greater rate of decline in water levels. However, above-normal precipitation and unfavorable economic conditions caused the number of new wells installed to decrease from 1976 to 1979. By the end of 1979 a total of 17,595 irrigation wells had been drilled and registered in the East South-Central Division.

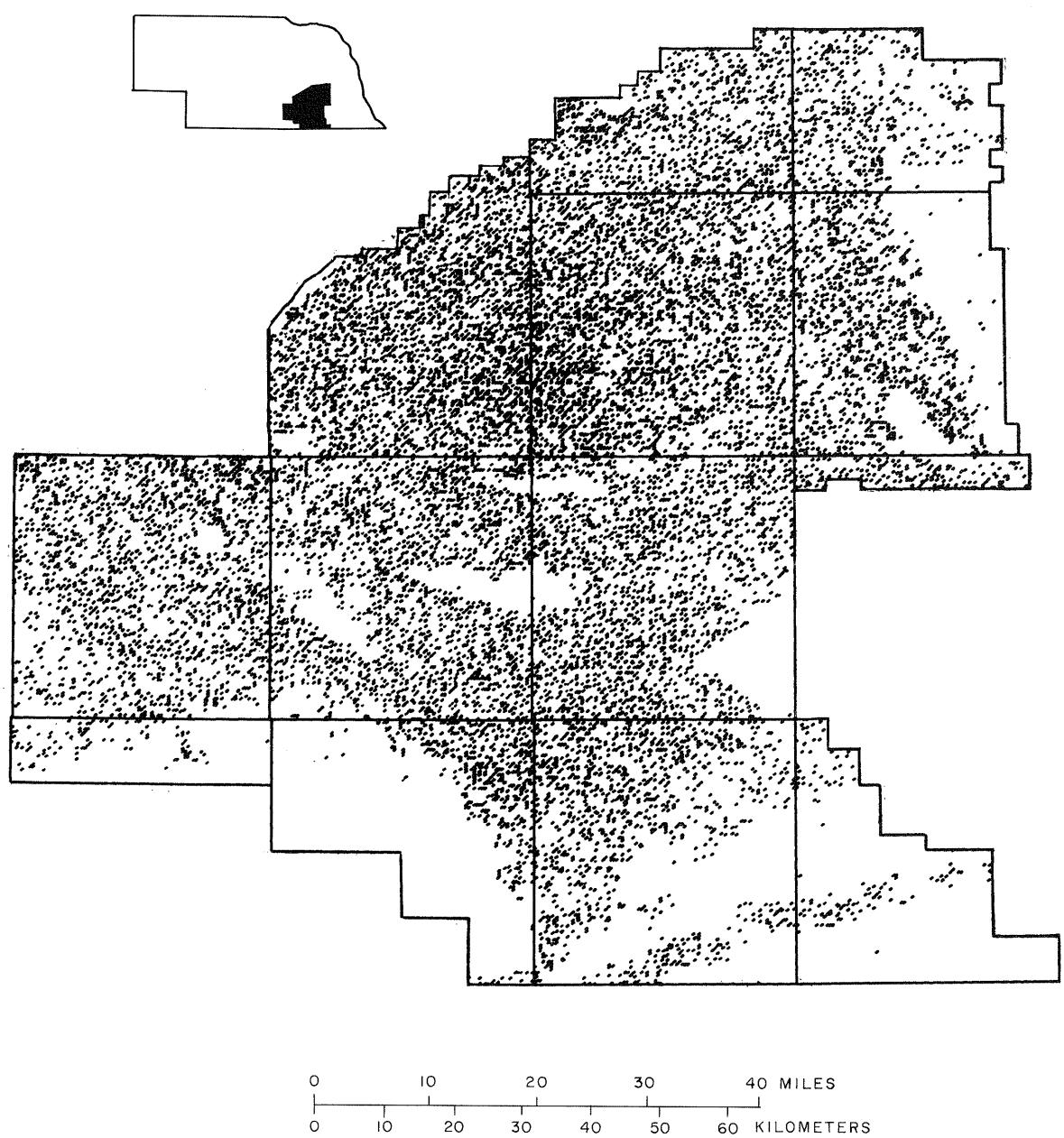
Irrigation wells have been drilled in almost all parts of this division where groundwater supplies are adequate for irrigation and where limitations on irrigation development—imposed by factors such as land use, soil type, or topography—are not restrictive.

Approximate areas of significant water-level declines from estimated predevelopment water levels in spring 1979 were:

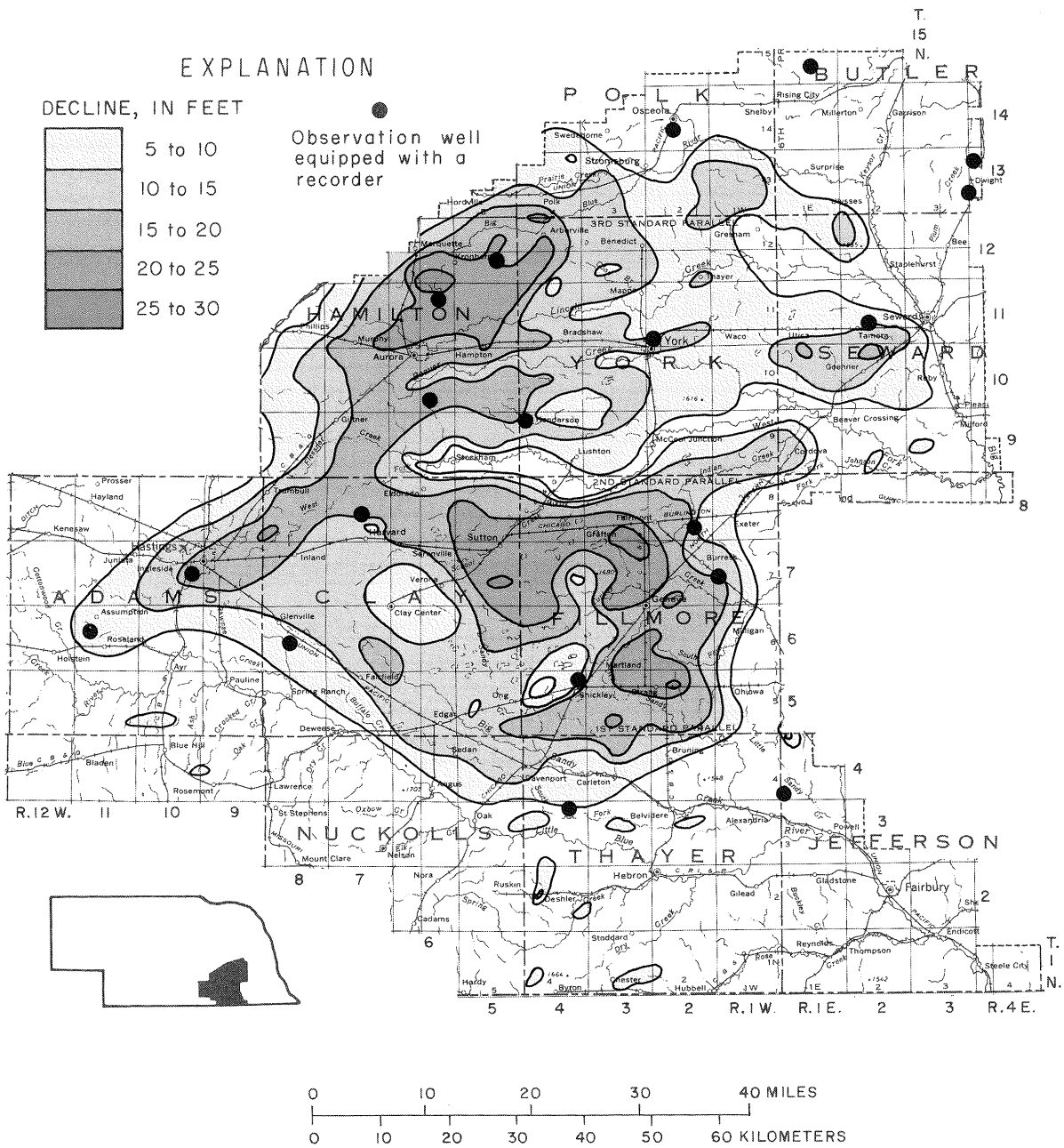
Amount of decline, in feet (meters, m)	Approximate area, in acres (square kilometers, km²)
5.00-10.00 (1.52-3.05)	610,000 (2 470)
10.00-15.00 (3.05-4.55)	580,000 (2 360)
15.00-20.00 (4.55-6.1)	355,000 (1 440)
20.00-25.00 (6.1-7.6)	179,000 (720)
25.00 or more (7.6 or more)	10,500 (42.5)



Areas of significant water-level change in the East South-Central Division from 1950 to fall 1979



Location of registered irrigation wells in the East South-Central Division as of December 31, 1979



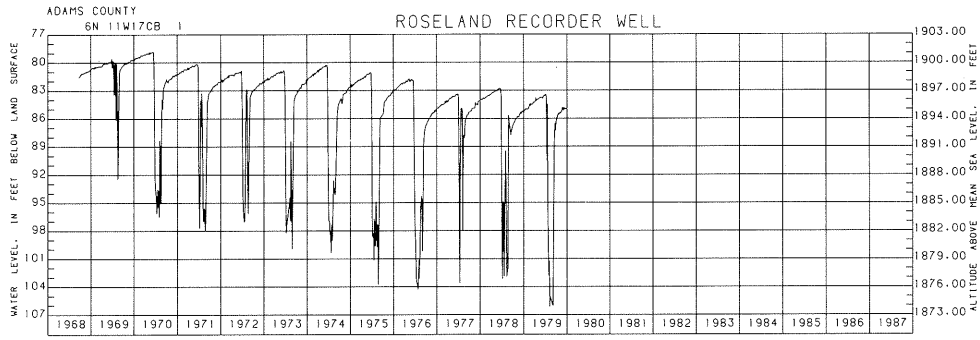
Areas of significant water-level change in the East South-Central Division from 1950 to spring 1979

Adams County: Roseland

Estimated predevelopment water level: 77 ft (23.5 m)

Net water-level change in 1979: +0.30 ft (+0.091 m)

Average annual net water-level change since 1968: −0.40 ft (−0.122 m)

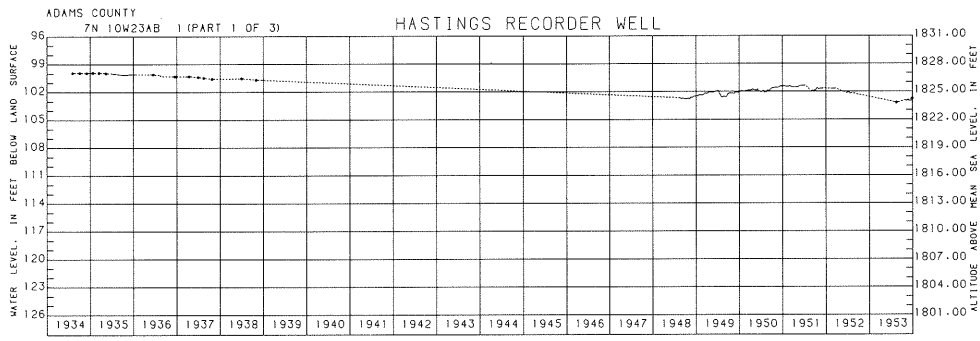


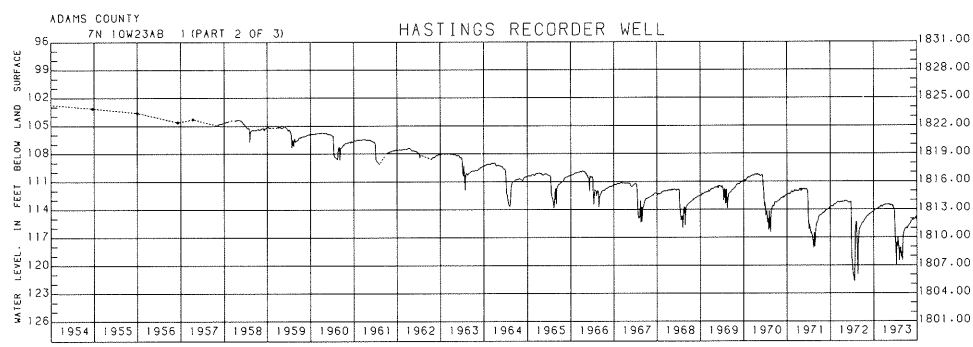
Adams County: Hastings

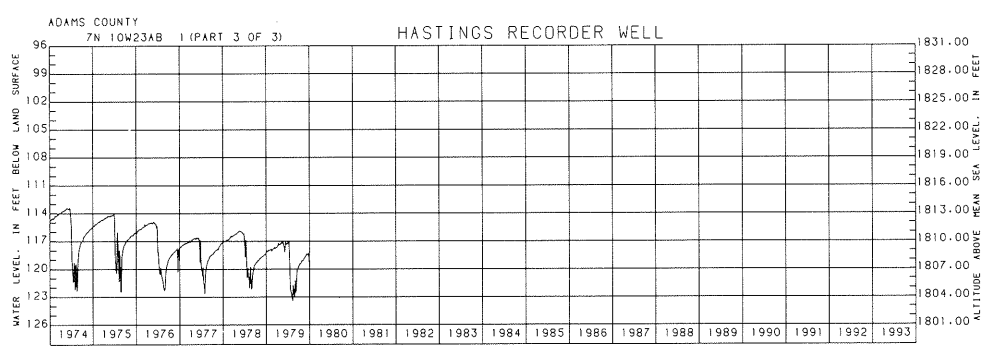
Estimated predevelopment water level: 102 ft (31.0 m)

Net water-level change in 1979: −1.12 ft (−0.340 m)

Average annual net water-level change since 1934: −0.43 ft (−0.131 m)





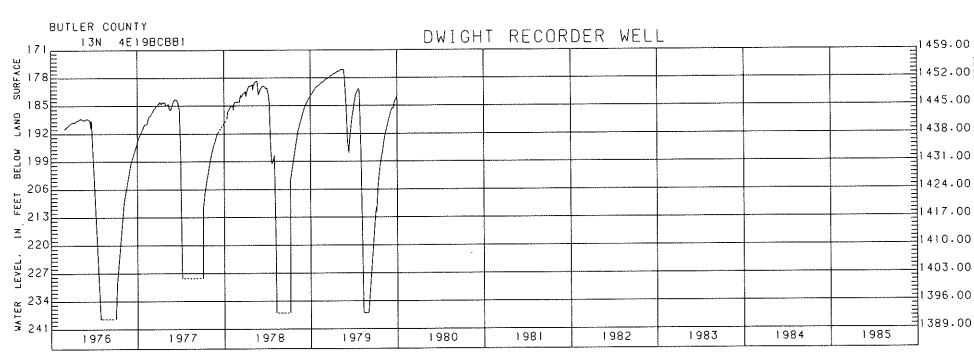


Butler County: Dwight

Estimated predevelopment water level: 197 ft (60 m)

Net water-level change in 1979: −0.03 ft (−0.009 1 m)

Average annual net water-level change since 1976: Not determinable

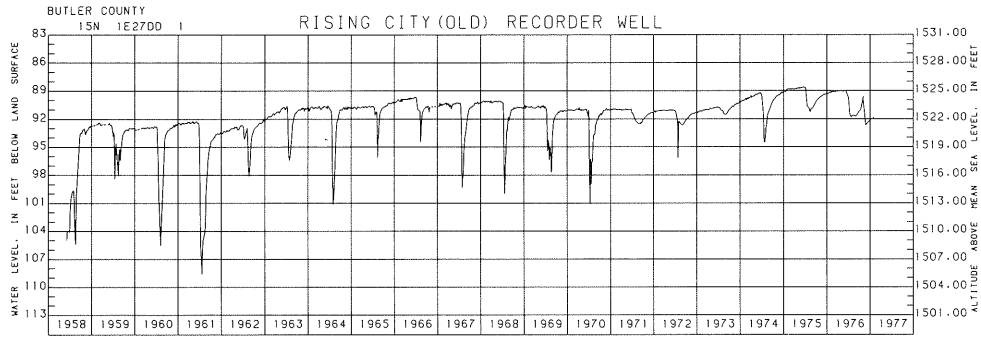


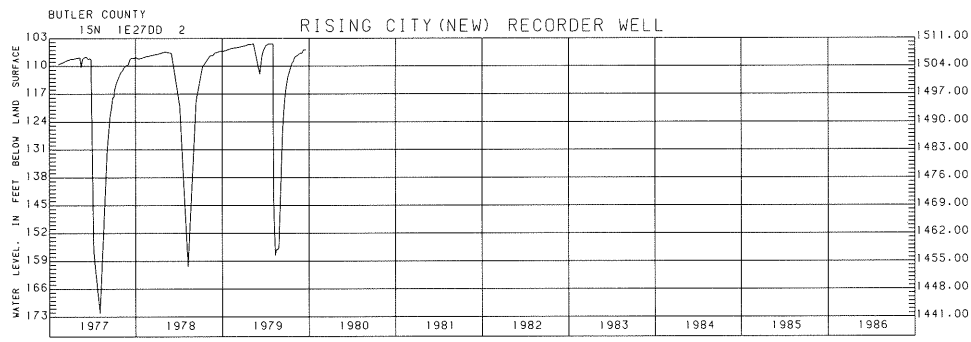
Butler County: Rising City

Estimated predevelopment water level: 104 ft (31.5 m)

Net water-level change in 1979: Not determinable

Average annual net water-level change since 1977: Not determinable



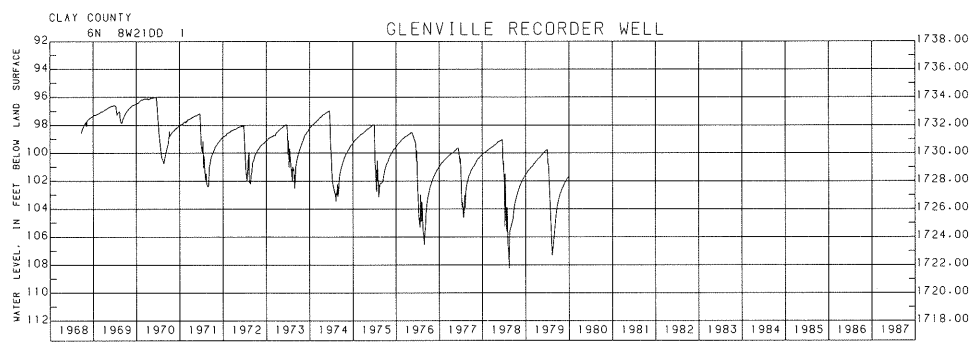


Clay County: Glenville

Estimated predevelopment water level: 93 ft (28.0 m)

Net water-level change in 1979: −0.10 ft (−0.030 5 m)

Average annual net water-level change since 1968: −0.47 ft (−0.143 m)

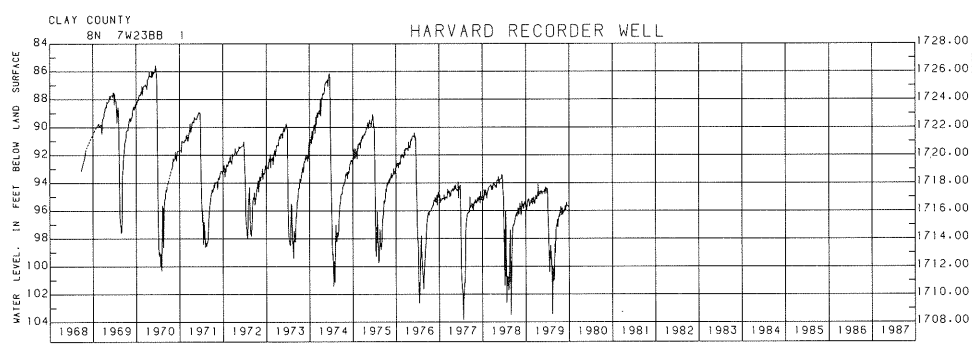


Clay County: Harvard

Estimated predevelopment water level: 79 ft (24.1 m)

Net water-level change in 1979: +0.05 ft (+0.015 2 m)

Average annual net water-level change since 1968: − 0.50 ft (−0.152 m)

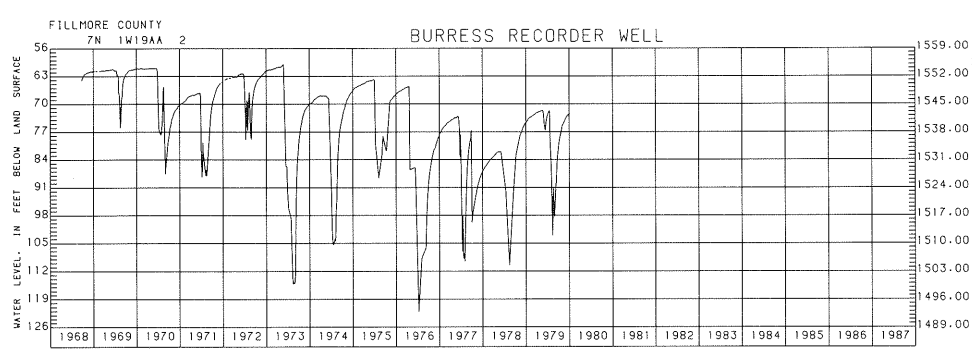


Fillmore County: Burress

Estimated predevelopment water level: 57 ft (17.4 m)

Net water-level change in 1979: +2.14 ft (+0.65 m)

Average annual net water-level change since 1968: −0.96 ft (−0.295 m)

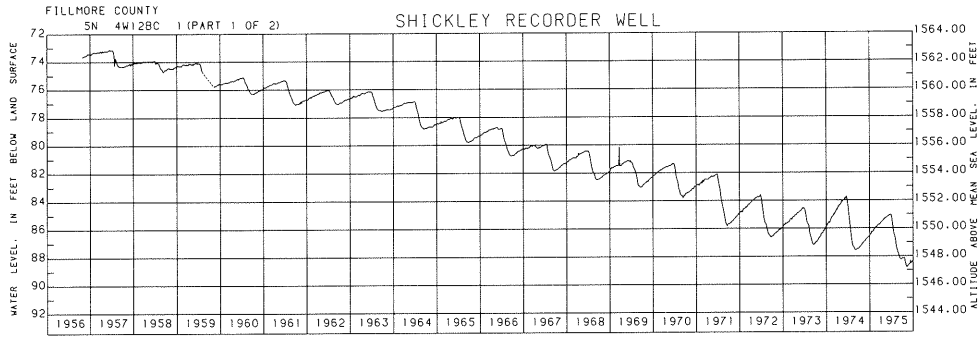


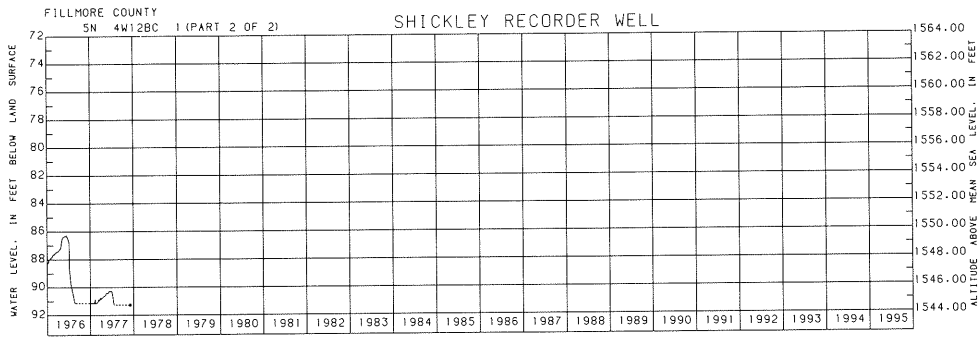
Fillmore County: Shickley

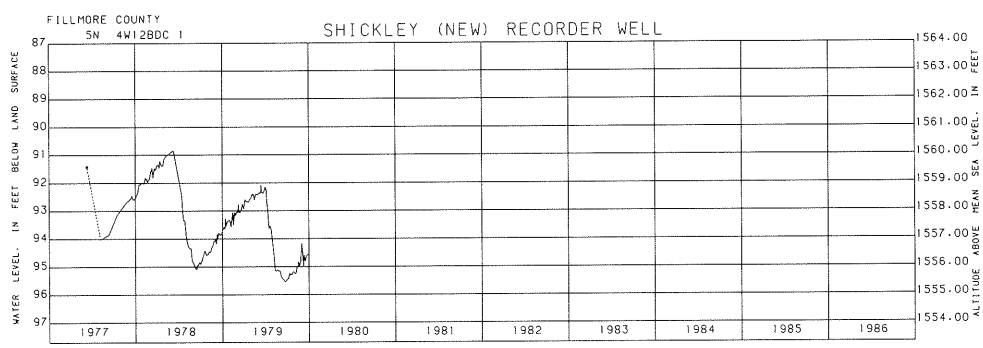
Estimated predevelopment water level: Old well, 73 ft (22.3 m); new well, 72 ft (21.9 m)

Net water-level change in 1979: −0.83 ft (−0.255 m)

Average annual net water-level change since 1977: −0.91 ft (−0.275 m)





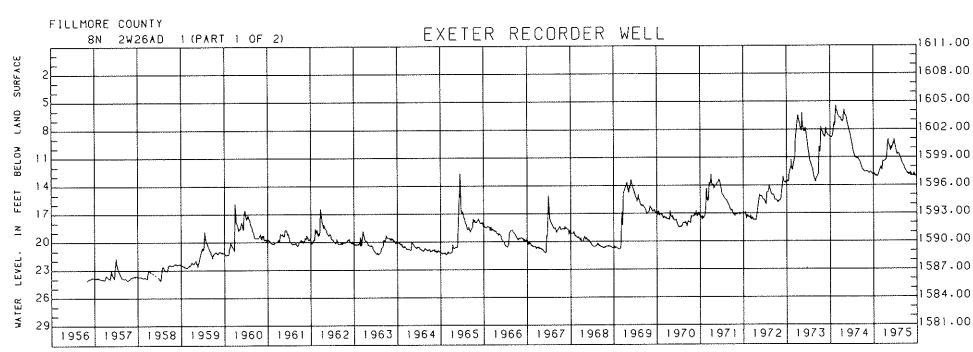


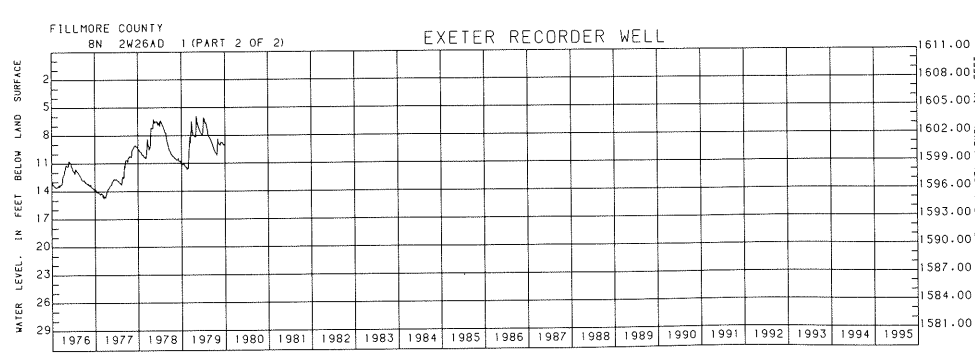
Fillmore County: Exeter

Estimated predevelopment water level: 24 ft (7.3 m)

Net water-level change in 1979: +1.91 ft (+0.58 m)

Average annual net water-level change since 1956: +0.64 ft (+0.195 m)



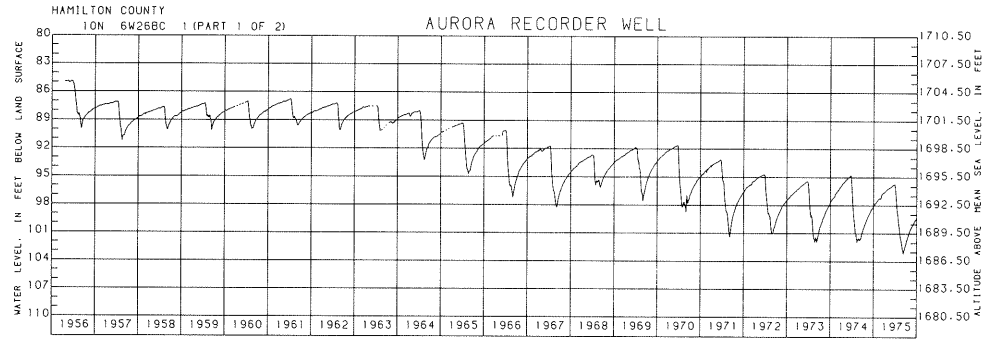


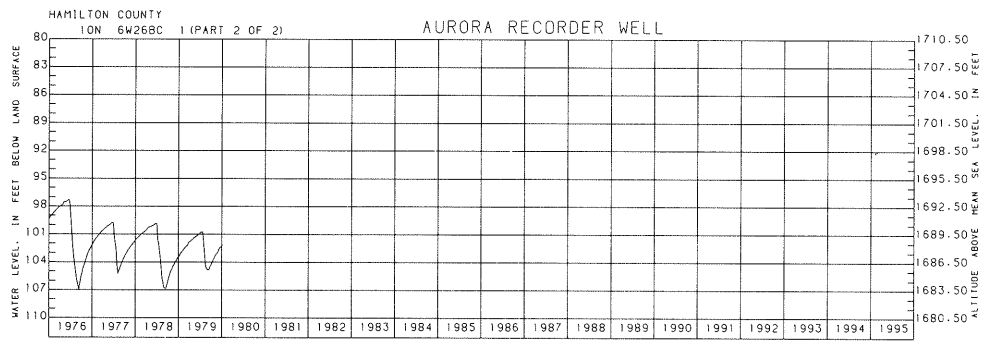
Hamilton County: Aurora

Estimated predevelopment water level: 83 ft (25.0 m)

Net water-level change in 1979: +1.24 ft (+0.380 m)

Average annual net water-level change since 1956: −0.62 ft (−0.189 m)



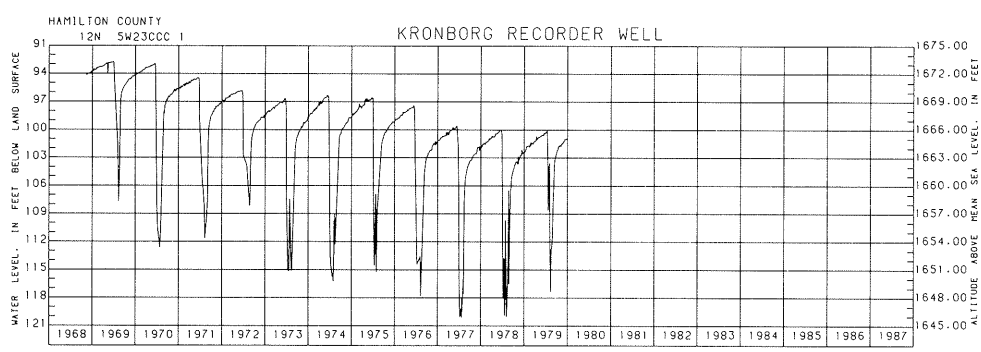


Hamilton County: Kronborg

Estimated predevelopment water level: 81 ft (24.7 m)

Net water-level change in 1979: +1.89 ft (+0.58 m)

Average annual net water-level change since 1968: −0.63 ft (−0.192 m)

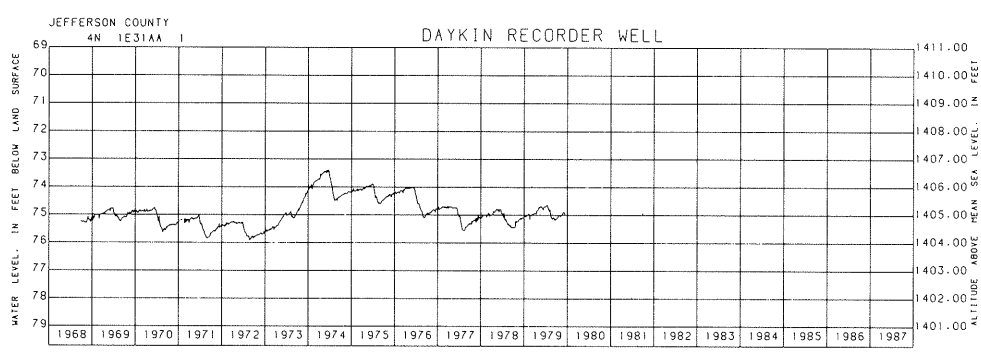


Jefferson County: Daykin

Estimated predevelopment water level: 74 ft (22.6 m)

Net water-level change in 1979: +0.12 ft (+0.036 5 m)

Average annual net water-level change since 1968: +0.03 ft (+0.009 1 m)

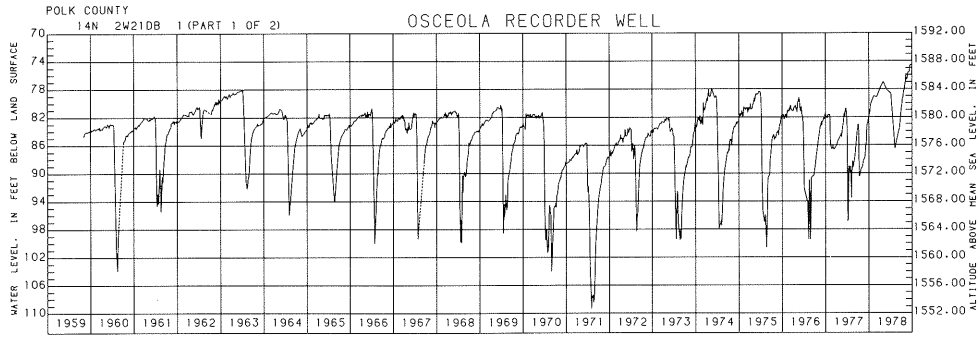


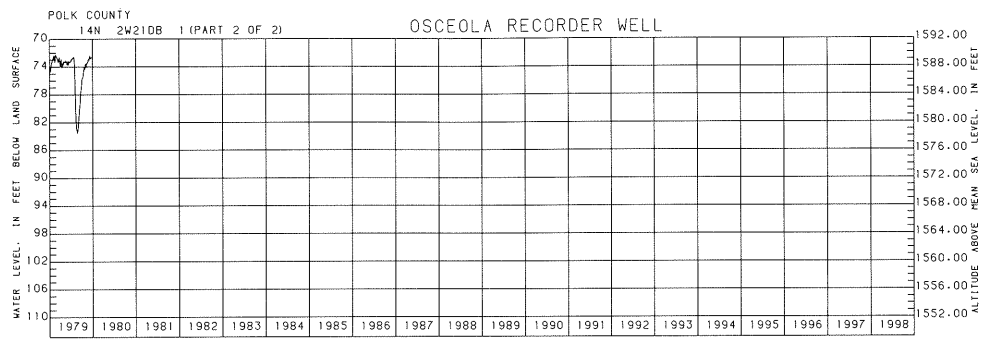
Polk County: Osceola

Estimated predevelopment water level: 80 ft (24.4 m)

Net water-level change in 1979: −2.02 ft (−0.62 m)

Average annual net water-level change since 1959: +0.56 ft (+0.171 m)



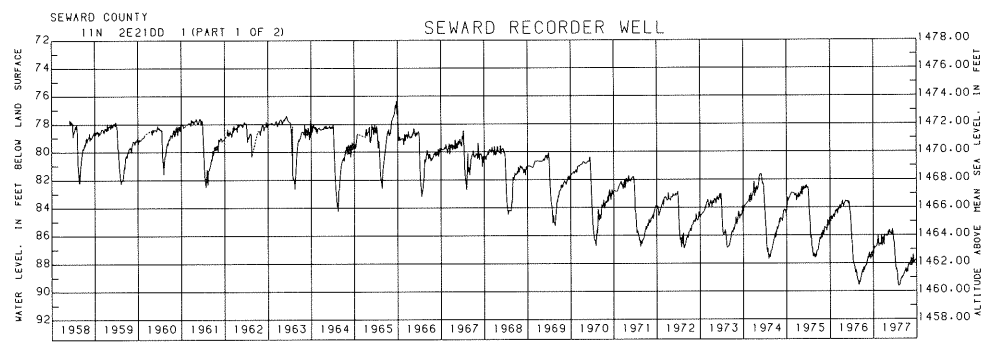


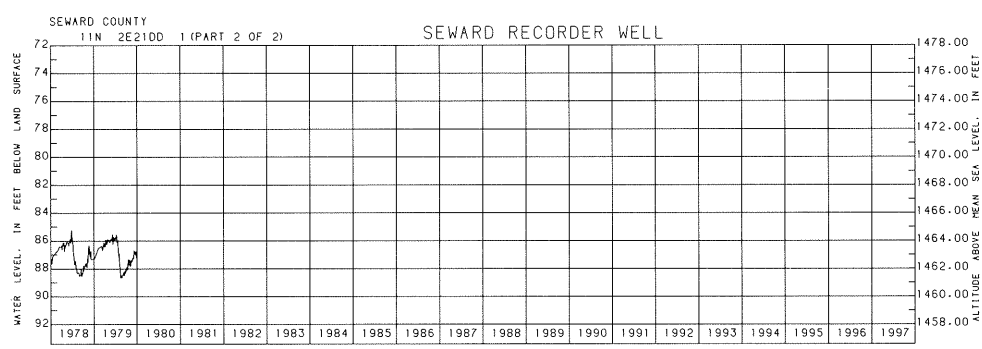
Seward County: Seward

Estimated predevelopment water level: 74 ft (22.6 m)

Net water-level change in 1979: +0.59 ft (+0.180 m)

Average annual net water-level change since 1958: −0.38 ft (−0.116 m)



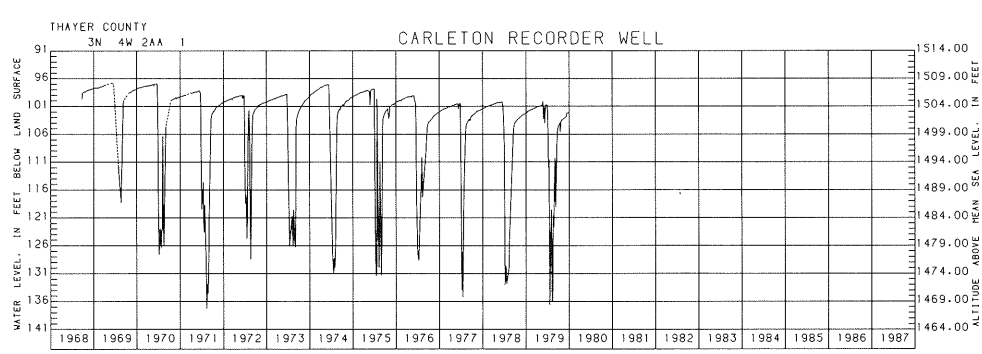


Thayer County: Carleton

Estimated predevelopment water level: 95 ft (29.0 m)

Net water-level change in 1979: −0.21 ft (−0.064 m)

Average annual net water-level change since 1968: −0.43 ft (−0.131 m)

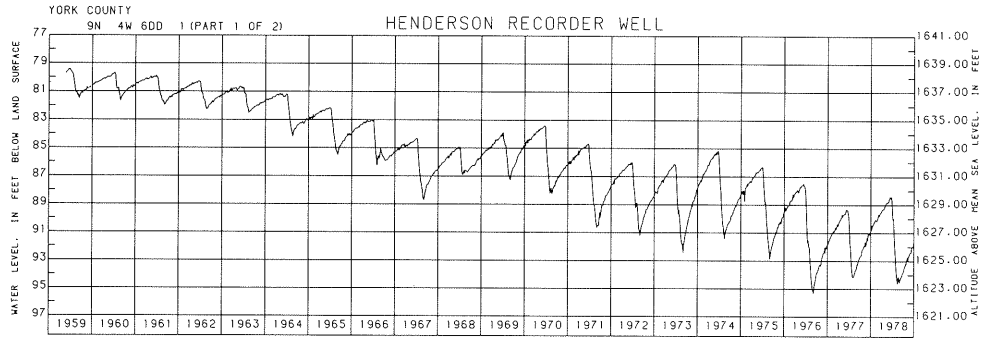


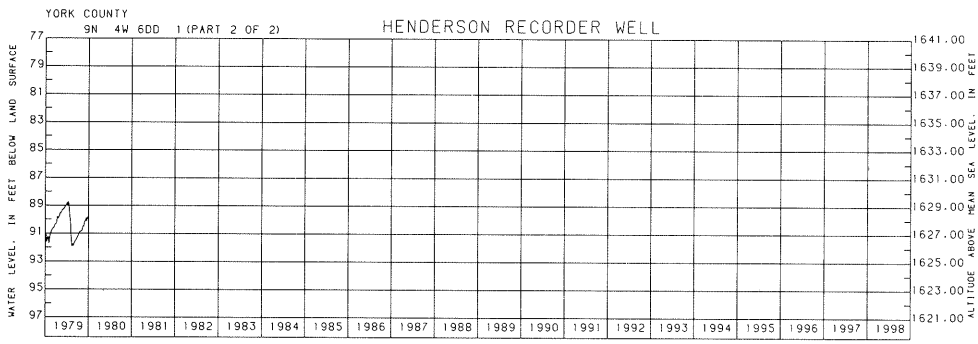
York County: Henderson

Estimated predevelopment water level: 80 ft (24.4 m)

Net water-level change in 1979: +2.03 ft (+0.62 m)

Average annual net water-level change since 1959: −0.45 ft (−0.137 m)



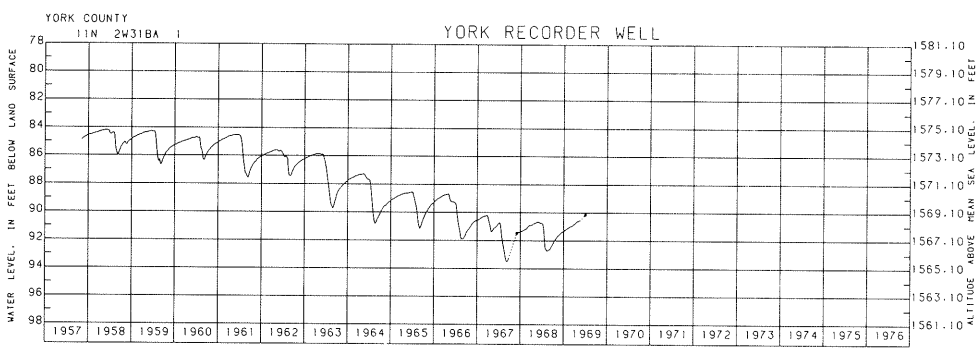


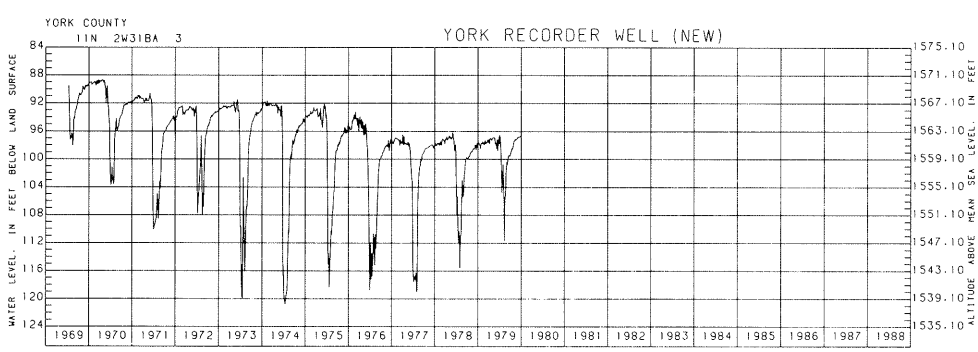
York County: York

Estimated predevelopment water level: Old well, 84 ft (25.5 m); new well, 85 ft (26.0 m)

Net water-level change in 1979: +1.06 ft (+0.325 m)

Average annual net water-level change since 1969: −0.73 ft (−0.222 m)





West South-Central Division

Between fall 1978 and fall 1979, water levels rose an average of 1.4 ft (0.425 m) in observation wells in the West South-Central Division, which includes the Tri-Basin Natural Resources District and Lower Republican Natural Resources District. Although most rises were less than 2 ft (0.61 m), rises of 4 to 6 ft (1.22 to 1.83 m) occurred in a few wells in northern Gosper, southeastern Phelps, and southwestern Kearney counties.

The water-level rise since predevelopment in the Tri-County area is the greatest in Nebraska. In this area, water released from storage in Lake McConaughy and subsequently diverted from the Platte River near North Platte has been used for irrigation since about 1940. Deep percolation of water from the irrigation distribution system and from water applied to crops has raised the water table 10 ft (3.05 m) or more from its estimated predevelopment level beneath approximately 535,000 acres (2 170 km^2). The greatest known water-level rise from predevelopment level, about 89 ft (27.0 m), occurred approximately 6.5 mi (10.5 km) north-northwest of Holdrege in Phelps County. Maximum known rises in the other counties in the area were approximately 63 ft (19.2 m) in Kearney County and more than 82 ft (25.0 m) in Gosper County.

In fall 1979 approximate areas of significant water-level rises from estimated predevelopment water levels were:

Amount of rise, in feet (meters, m)	Approximate area, in acres (square kilometers, km^2)	
10.00-20.00 (3.05-6.1)	113,000	(460)
20.00-50.00 (6.1-15.2)	218,000	(880)
50.00 or more (15.2 or more)	204,000	(830)

Estimated predevelopment water levels are about equal to average water levels prior to 1940.

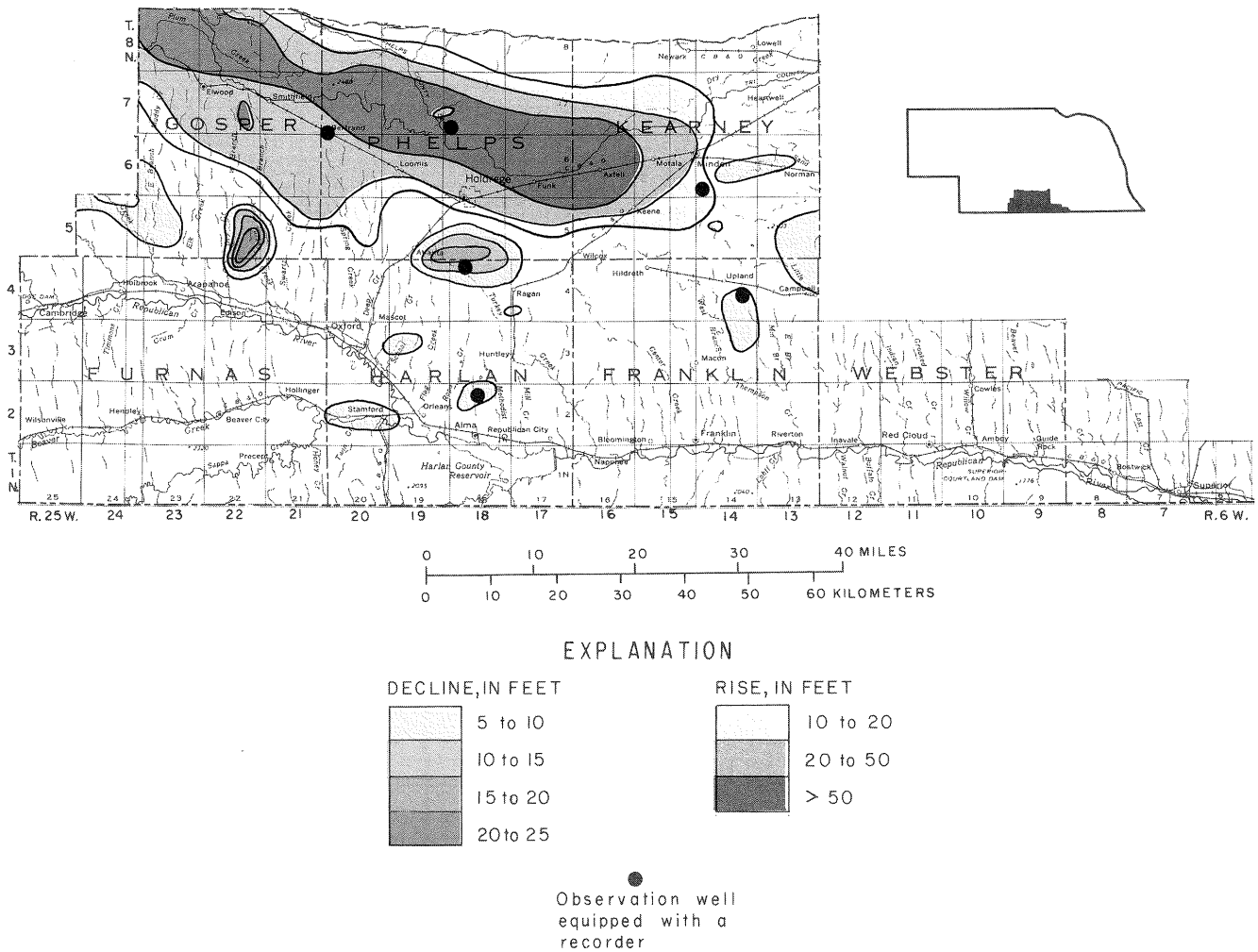
Use of groundwater for irrigation, plus the pumping of groundwater into the Tri-County Supply Canal, has slowed the rate of water-level rise in many parts of the area. In one locality where large quantities of groundwater are pumped into the canal, water levels have dropped more than 5 ft (1.52 m) since about 1970. In some parts of the area, the water table has risen so high that evapotranspiration losses and groundwater discharge into streams have stabilized water levels.

Increased use of groundwater for irrigation in recent years has lowered water levels significantly below estimated predevelopment levels in several small areas. Declines of 5 ft (1.52 m) or a little more have occurred in areas totaling about 135,000 acres (550 km^2).

In fall 1979 approximate areas of significant water-level declines from estimated predevelopment water levels were:

Amount of decline, in feet (meters, m)	Approximate area, in acres (square kilometers, km^2)	
5.00-10.00 (1.52-3.05)	104,000	(420)
10.00-15.00 (3.05-4.55)	18,700	(76)
15.00-20.00 (4.55-6.1)	12,200	(49.5)
20.00-25.00 (6.1-7.6)	780	(3.15)

Data for estimation of predevelopment water levels are generally adequate, except for the period 1940 to 1947 when few data were collected. Water-level measurement programs have provided enough data for a good evaluation of both water-level changes since 1947 and definition of current water-level changes.



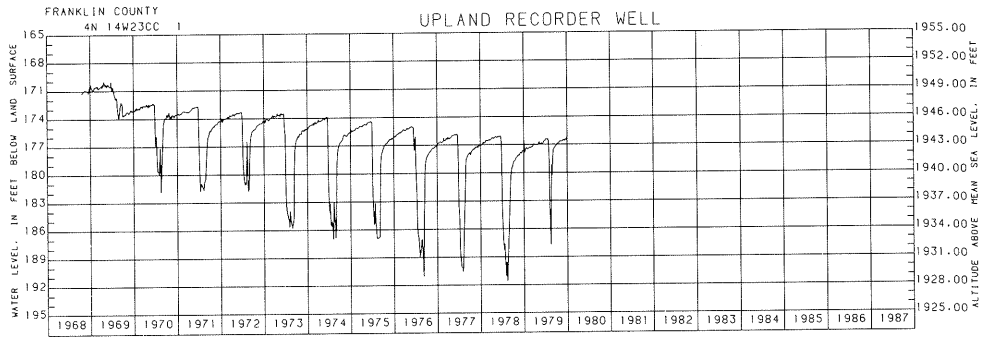
Areas of significant water-level change in the West South-Central Division from 1940 to fall 1979

Franklin County: Upland

Estimated predevelopment water level: 170 ft (52 m)

Net water-level change in 1979: +1.32 ft (+0.400 m)

Average annual net water-level change since 1968: −0.56 ft (−0.171 m)

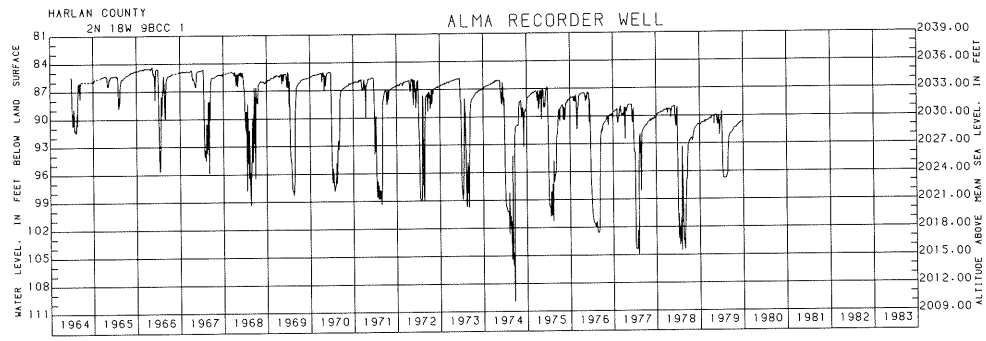


Harlan County: Alma

Estimated predevelopment water level: 85 ft (26.0 m)

Net water-level change in 1979: −0.30 ft (−0.091 m)

Average annual net water-level change since 1964: −0.33 ft (−0.101 m)

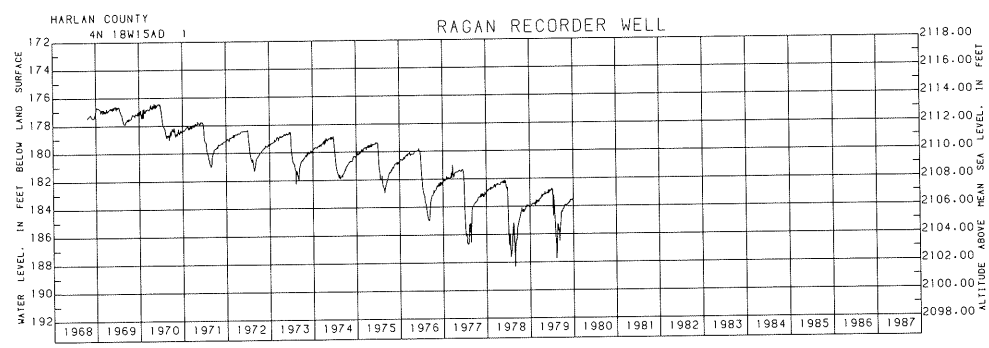


Harlan County: Ragan

Estimated predevelopment water level: 176 ft (54 m)

Net water-level change in 1979: +0.69 ft (+0.210 m)

Average annual net water-level change since 1968: −0.61 ft (−0.186 m)

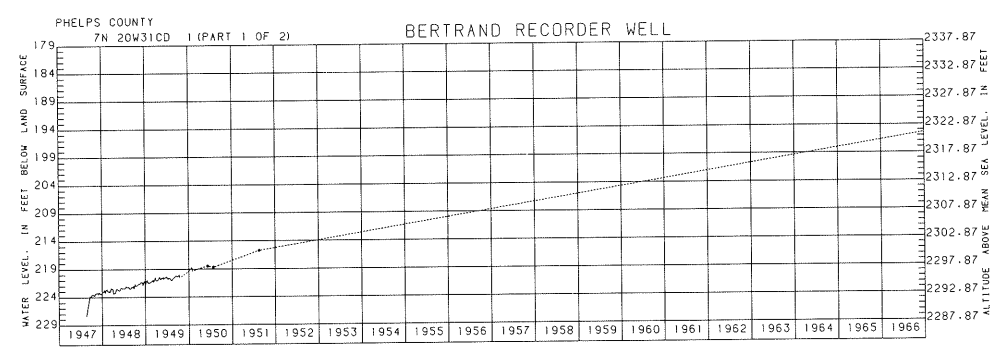


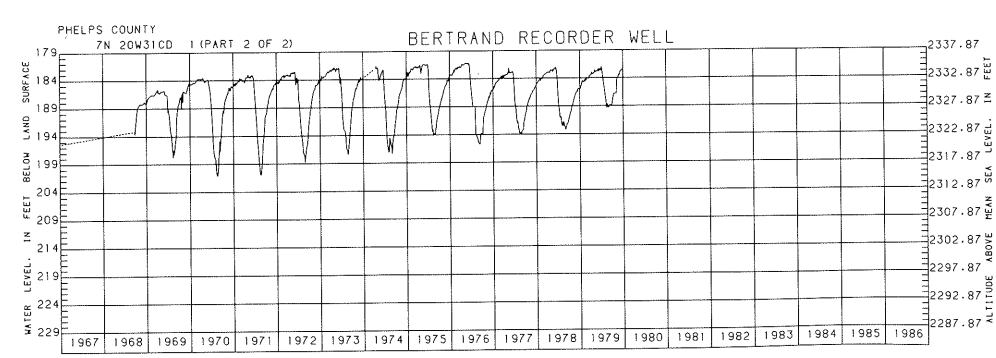
Phelps County: Bertrand

Estimated predevelopment water level: 232 ft (71 m)

Net water-level change in 1979: +3.95 ft (+1.20 m)

Average annual net water-level change since 1948: +1.31 ft (+0.400 m)



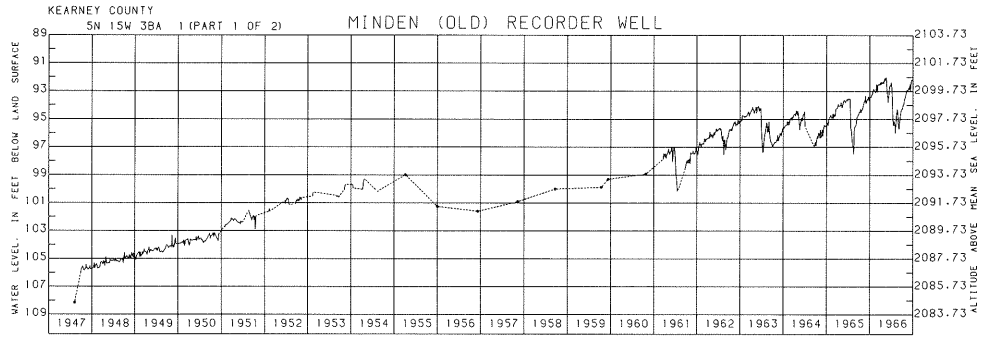


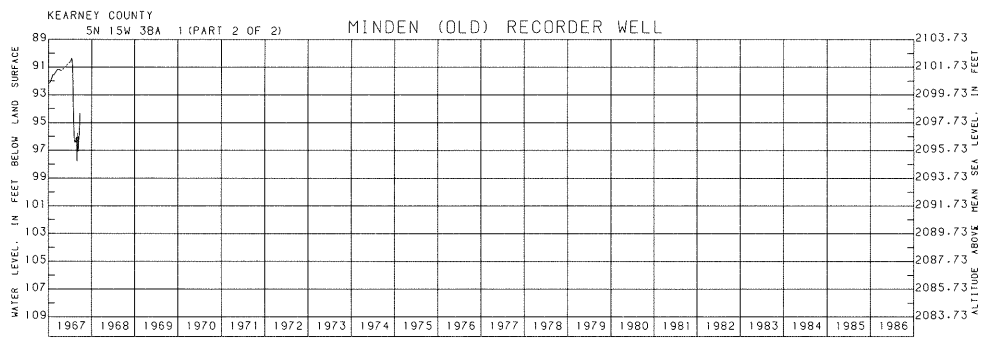
Kearney County: Minden

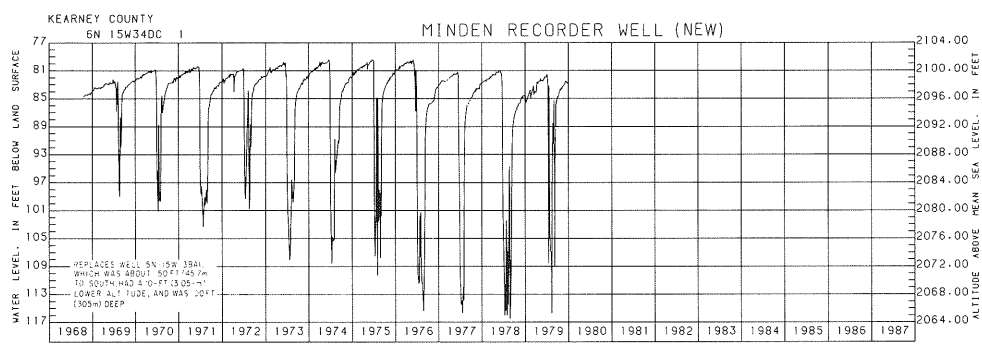
Estimated predevelopment water level: Old well, 113 ft (34.5 m); new well, 103 ft (31.5 m)

Net water-level change in 1979: +2.42 ft (+0.74 m)

Average annual net water-level change since 1968: +0.16 ft (+0.049 0 m)





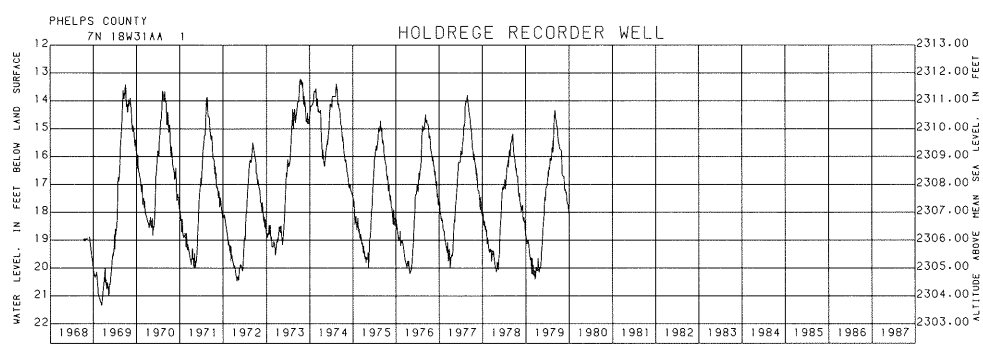


Phelps County: Holdrege

Estimated predevelopment water level: 100 ft (30.5 m)

Net water-level change in 1979: +0.90 ft (+0.275 m)

Average annual net water-level change since 1968: +0.18 ft (+0.055 m)



Central Division

Water levels in most observation wells in the Central Division were higher in fall 1979 than in fall 1978. Although net water-level rises averaged 0.6 ft (0.183 m), maximum rises of a little more than 4 ft (1.22 m) occurred in a few wells in Hall and Merrick counties. In some areas water levels declined, the largest declines occurring in northern Hall and northwestern Valley counties.

Declines of 5 ft (1.52 m) or more from estimated predevelopment water levels occurred in a total area of about 490,000 acres (1 980 km²). The largest area of decline is in Dawson, Buffalo, Hall, and Merrick counties—an area referred to in previous reports as the Central Platte or Platte Valley area. Water levels have declined a little more than 20 ft (6.1 m) in some wells on the uplands north of Wood River in Buffalo County, where intensive groundwater development for irrigation has resulted in progressive water-level declines since 1968. In lowland areas where the depth to water below land surface is less than 30 ft (9.1 m), long-term water levels have not declined because recharge by precipitation is supplemented by river seepage and losses from evapotranspiration have decreased.

In southwestern Valley County, pumping for irrigation has caused water-level declines of 5 ft (1.52 m) or more from estimated predevelopment levels. In this area—referred to in previous reports as the Valley County or Mira Valley area—the maximum decline of 13.3 ft (4.05 m) is in a well located west of Ord.

In fall 1979 approximate areas of significant water-level declines from estimated predevelopment water levels in the Central Division were as follows:

Amount of decline, in feet (meters, m)	Approximate area, in acres (square kilometers, km²)	
5.00-10.00 (1.52-3.05)	345,000	(1 400)
10.00-15.00 (3.05-4.55)	134,000	(540)
15.00-20.00 (4.55-6.1)	9,000	(36.5)
20.00-25.00 (6.1-7.6)	510	(2.06)

Estimated predevelopment water levels are the approximate water levels prior to 1957 in Valley County, in the early 1930s in the lowlands adjacent to the Platte and Wood rivers, and prior to 1951 in the uplands of Buffalo and Hall counties. Sufficient data are available for good definition of estimated predevelopment levels; moreover, existing water-level measurement programs provide data for good definition of current water-level changes in most areas.

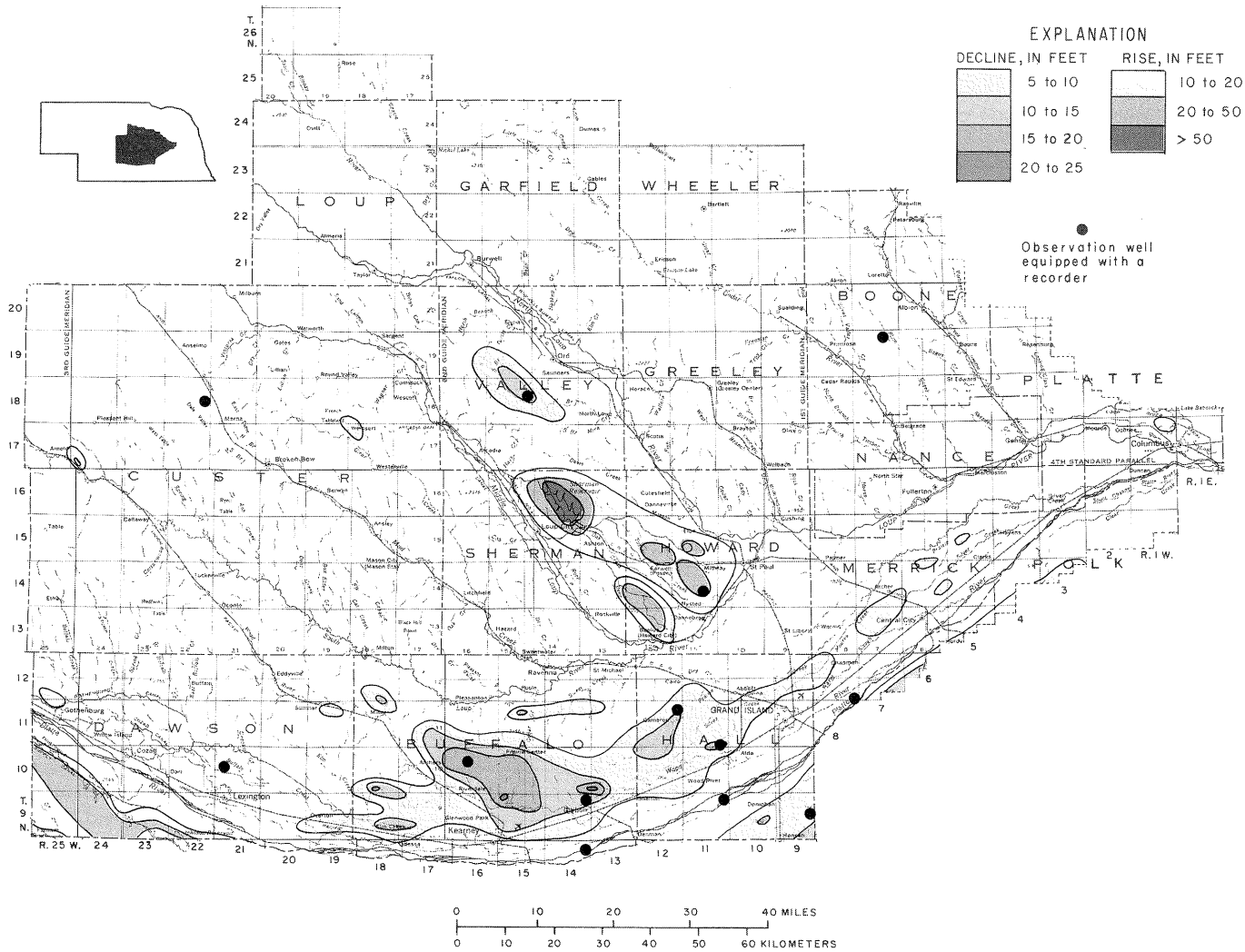
Water-level rises of 10 ft (3.05 m) or more from estimated predevelopment levels have occurred beneath about 179,000 acres (720 km²) in the part of Sherman and Howard counties referred to in previous reports as the Farwell area. Water levels began rising around 1963 because of water loss from irrigation canals, seepage from the Sherman Reservoir, and deep percolation of water applied to crops in the Farwell Irrigation Project. The greatest water-level rises—a little more than 67 ft (20.4 m)—are in the vicinity of the Sherman Reservoir. The current rate of rise is so slow that most water-level changes now are related to fluctuations in reservoir stage.

In fall 1979 approximate areas of significant water-level rises from estimated predevelopment levels were as follows:

Amount of rise, in feet (meters, m)	Approximate area, in acres (square kilometers, km²)	
10.00-20.00 (3.05-6.1)	120,000	(485)
20.00-50.00 (6.1-15.2)	45,500	(182)
50.00 or more (15.2 or more)	13,500	(55)

Estimated predevelopment water levels in the area are the approximate water levels prior to 1963.

Data available for the area provide a good basis for estimating predevelopment water levels, water-level changes since 1963, and current water-level changes.



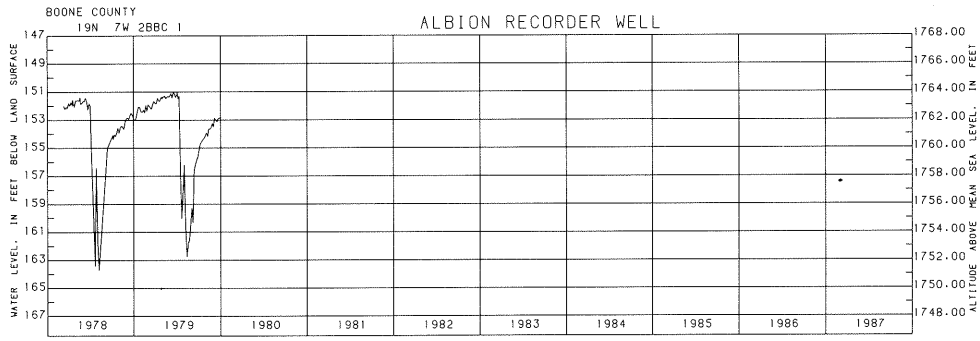
Areas of significant water-level change in the Central Division from 1951 to fall 1979

Boone County: Albion

Estimated predevelopment water level: Not determined

Net water-level change in 1979: +0.05 ft (+0.015 2 m)

Average annual net water-level change since 1978: +0.02 ft (+0.006 1 m)

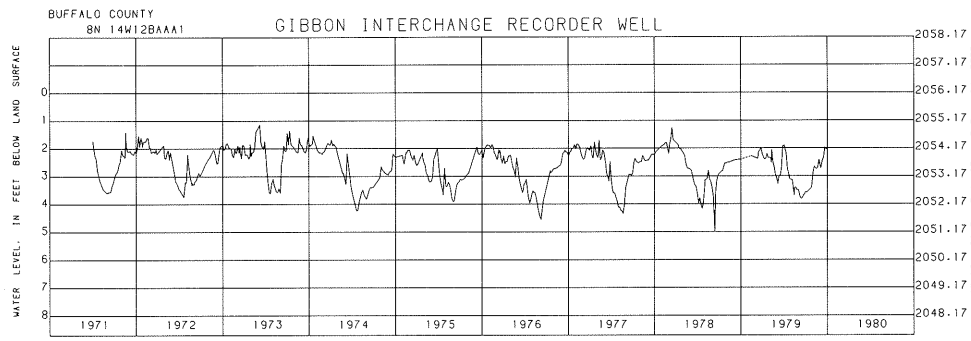


Buffalo County: Gibbon Interchange

Estimated predevelopment water level: 4 ft (1.22 m)

Net water-level change in 1979: +0.35 ft (+0.107 m)

Average annual net water-level change since 1971: −0.02 ft (−0.006 1 m)

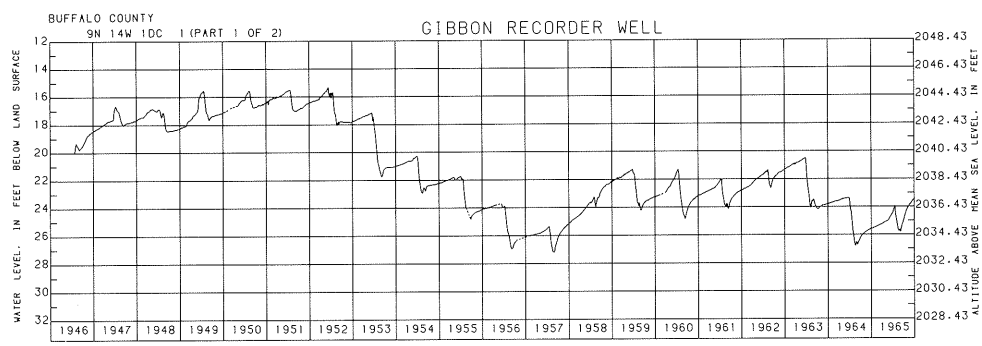


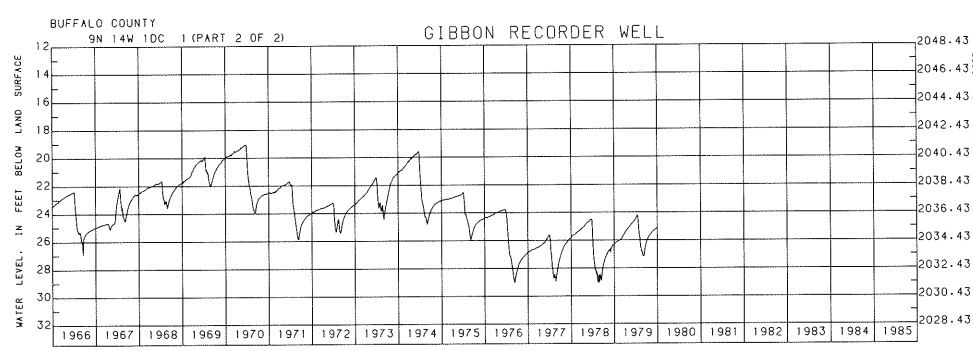
Buffalo County: Gibbon

Estimated predevelopment water level: 17.0 ft (5.2 m)

Net water-level change in 1979: +1.19 ft (+0.365 m)

Average annual net water-level change since 1946: −0.20 ft (−0.061 m)



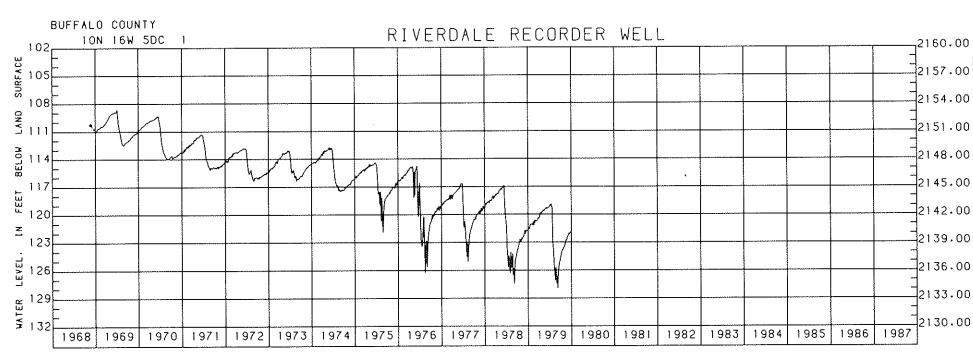


Buffalo County: Riverdale

Estimated predevelopment water level: 107 ft (32.5 m)

Net water-level change in 1979: −0.02 ft (−0.006 1 m)

Average annual net water-level change since 1968: −0.97 ft (−0.295 m)

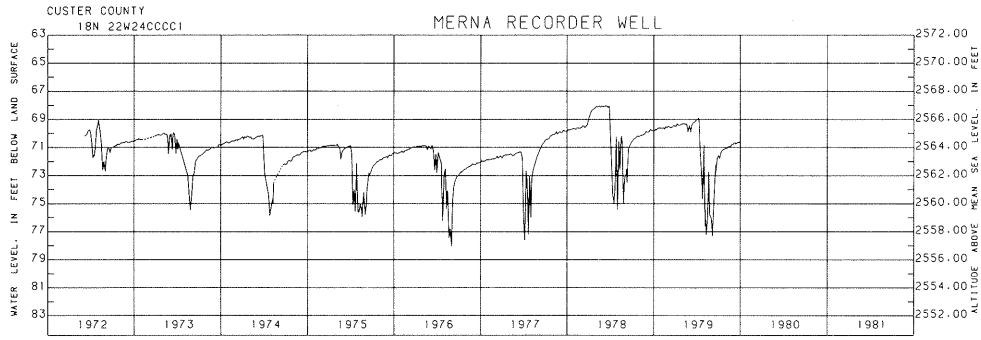


Custer County: Merna

Estimated predevelopment water level: 68 ft (20.7 m)

Net water-level change in 1979: −0.73 ft (−0.222 m)

Average annual net water-level change since 1972: Less than 0.01 ft (0.003 0 m)

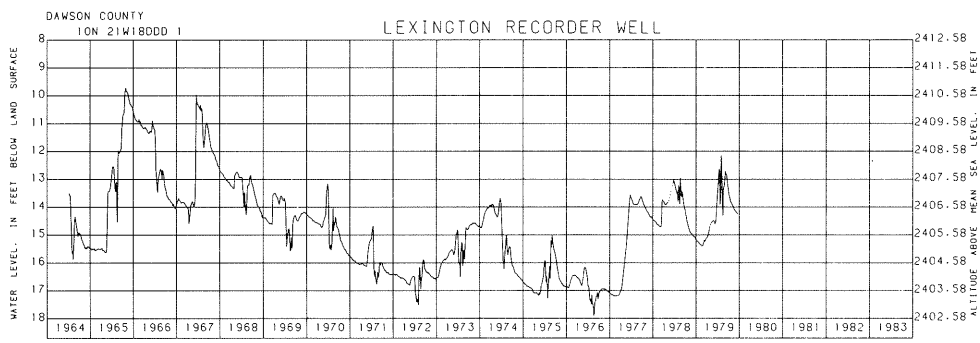


Dawson County: Lexington

Estimated predevelopment water level: 11 ft (3.35 m)

Net water-level change in 1979: +0.81 ft (+0.247 m)

Average annual net water-level change since 1964: +0.07 ft (+0.021 3 m)

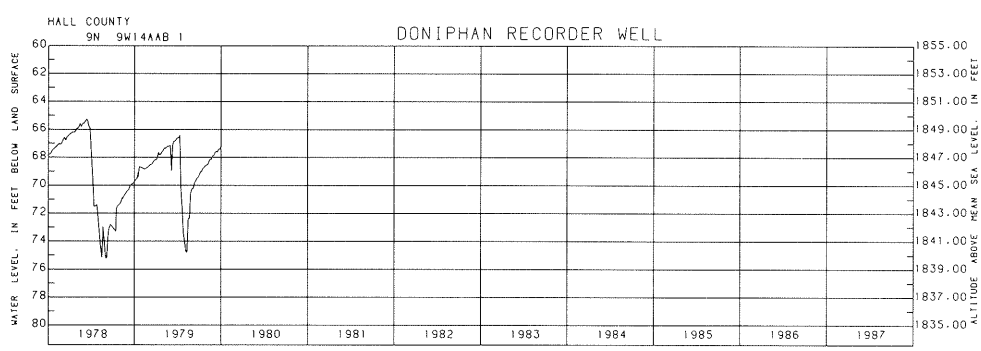


Hall County: Doniphan

Estimated predevelopment water level: 63 ft (19.2 m)

Net water-level change in 1979: +2.52 ft (+0.77 m)

Average annual net water-level change since 1978: +0.25 ft (+0.076 m)

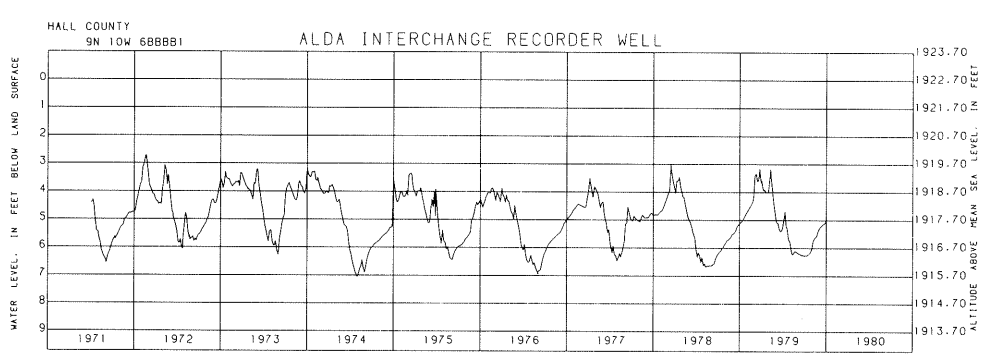


Hall County: Alda Interchange

Estimated predevelopment water level: 5 ft (1.52 m)

Net water-level change in 1979: +0.10 ft (+0.030 5 m)

Average annual net water-level change since 1971: Not significant; no long-term trend

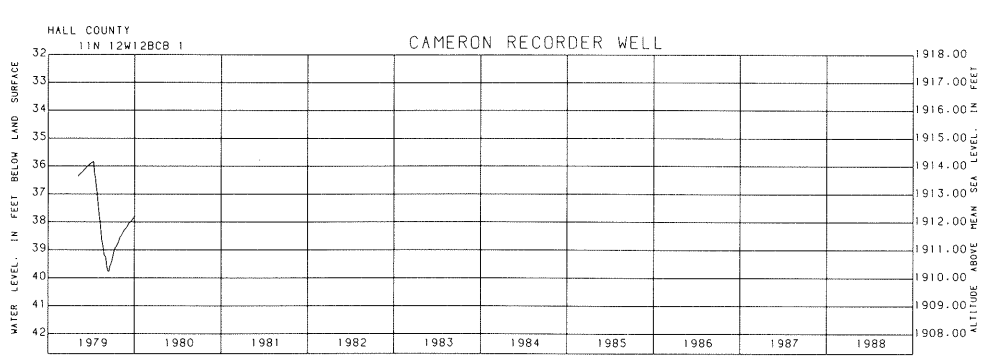


Hall County: Cameron

Estimated predevelopment water level: Not determined

Net water-level change in 1979: Not determinable

Average annual net water-level change since 1979: Not determinable

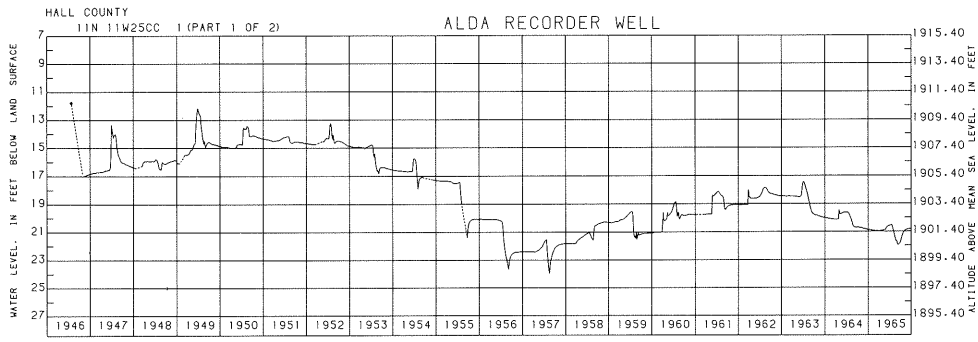


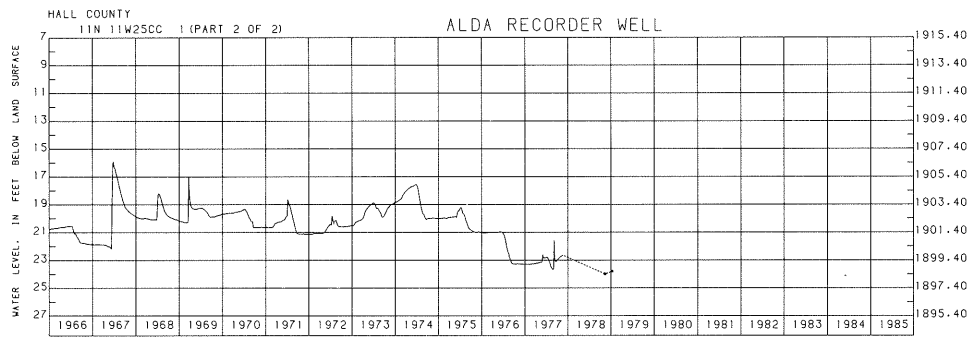
Hall County: Alda

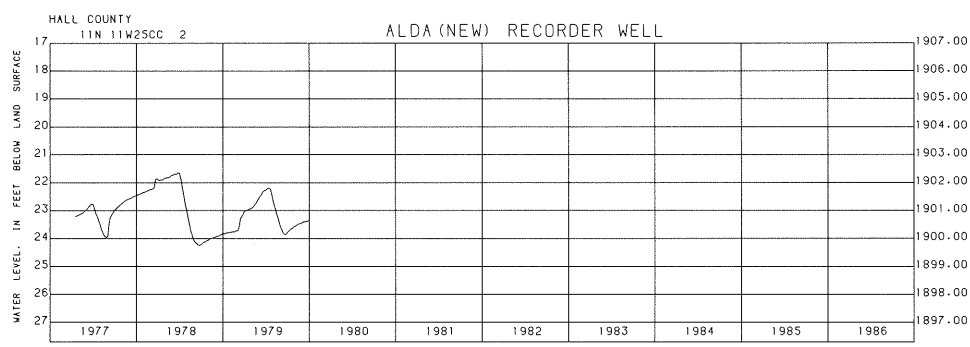
Estimated predevelopment water level: 15 ft (4.55 m)

Net water-level change in 1979: +0.49 ft (+0.149 m)

Average annual net water-level change since 1948: Not significant; no long-term trend





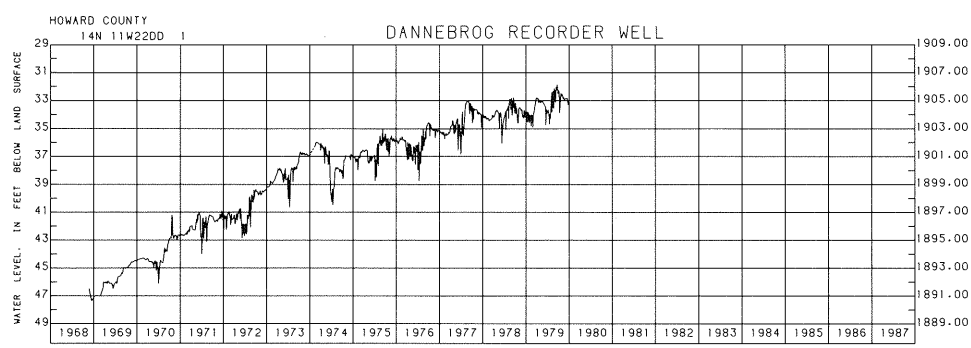


Howard County: Dannebrog

Estimated predevelopment water level: 62 ft (18.9 m)

Net water-level change in 1979: +1.12 ft (+0.340 m)

Average annual net water-level change since 1968: +1.24 ft (+0.380 m)

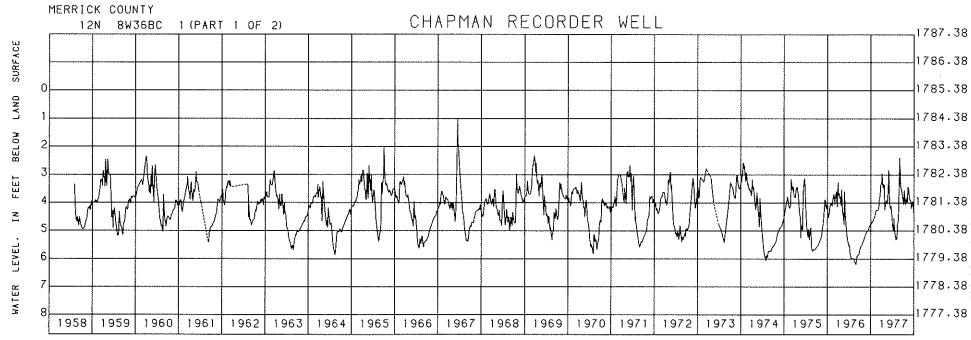


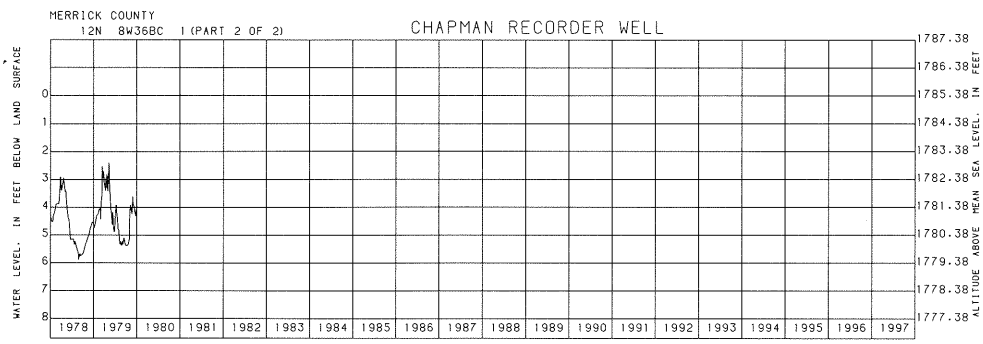
Merrick County: Chapman

Estimated predevelopment water level: 4 ft (1.22 m)

Net water-level change in 1979: +0.66 ft (+0.201 m)

Average annual net water-level change since 1958: Not significant; no long-term trend



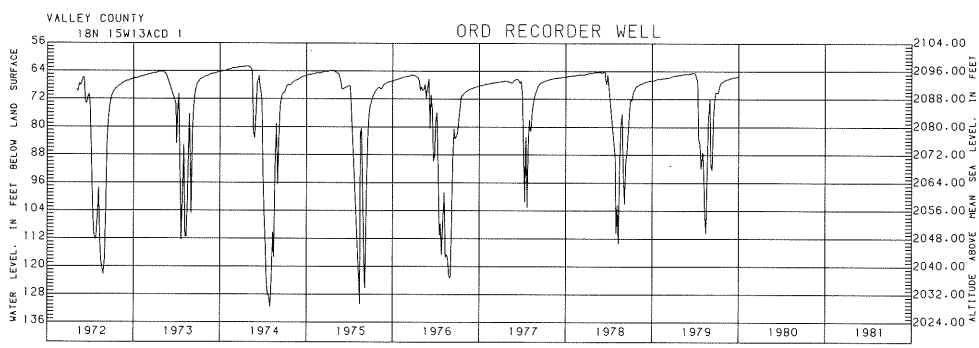


Valley County: Ord

Estimated predevelopment water level: 51 ft (15.5 m)

Net water-level change in 1979: +1.27 ft (+0.385 m)

Average annual net water-level change since 1972: +0.08 ft (+0.024 4 m)



East North-Central Division

Water levels in all observation wells measured in the East North-Central Division in fall 1979 averaged 0.04 ft (0.012 2 m) higher than those measured during fall 1978. They ranged from a maximum rise of 2.35 ft (0.72 m) in a well near O'Neill in Holt County to a maximum decline of 1.61 ft (0.490 m) in a well near Springview in Keya Paha County. No specific areas of rise or decline from fall 1978 to fall 1979 could be delineated.

By fall 1979 water-level declines of 5 ft (1.52 m) or more from estimated predevelopment levels had occurred in a total area of approximately 125,000 acres (500 km^2). The largest declines—a little over 21 ft (6.4 m)—occurred in two wells, one northwest of O'Neill and the other south of the site of the old town of Opportunity. Water levels declined 5 to 10 ft (1.52 to 3.05 m) in other areas of Holt and southern Antelope counties.

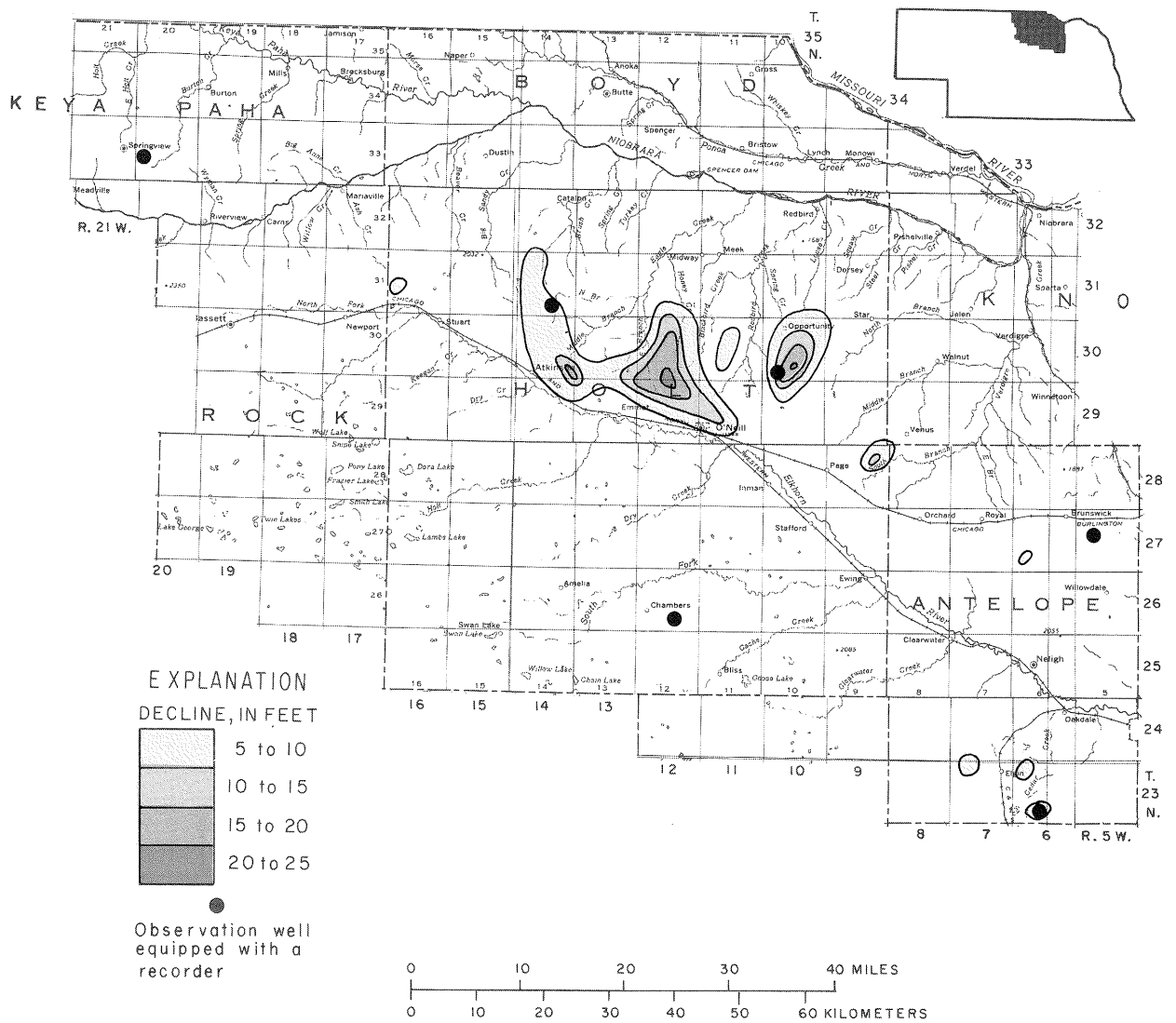
In fall 1979 approximate areas of significant water-level declines from estimated predevelpment water levels were as follows:

Amount of decline, in feet (meters, m)	Approximate area, in acres (square kilometers, km^2)	
5.00-10.00 (1.52-3.05)	85,000	(345)
10.00-15.00 (3.05-4.55)	23,300	(94)
15.00-20.00 (4.55-6.1)	14,200	(57)
20.00-25.00 (6.1-7.6)	1,950	(7.9)

Estimated predevelopment water levels in the area are the approximate water levels prior to 1957.

Withdrawal of water for irrigation has caused a progressive decline in water levels since 1964 in some parts of the area; however, recharge from precipitation occasionally has resulted in short-term water-level rises or has lessened the rate of water-level decline. Available data indicate that the water level in some wells declined 5 ft (1.52 m) or more during the drought of the mid-1950s and that the water levels in many wells rose more than 2 ft (0.61 m) between 1970 and 1974, when precipitation in the area was above normal. In much of the area, groundwater withdrawals for irrigation are large enough to cause net water-level declines in most years of near-normal or below-normal precipitation. In years or in irrigation seasons when precipitation is above normal, however, the water level in most wells rises in response to the greater recharge from precipitation in combination with less-than-normal pumpage. In 1979, when precipitation was normal to above normal from early spring through the irrigation season, the water level in most wells rose following the irrigation season to a level almost as high or even higher than in fall 1978.

Sufficient data are available for a fairly good estimation of predevelopment water levels in the area and the existing observation-well network provides adequate data for evaluation of current water-level changes. Prior to 1975, however, observation wells in many parts of the area were too few to define the water-level changes adequately.



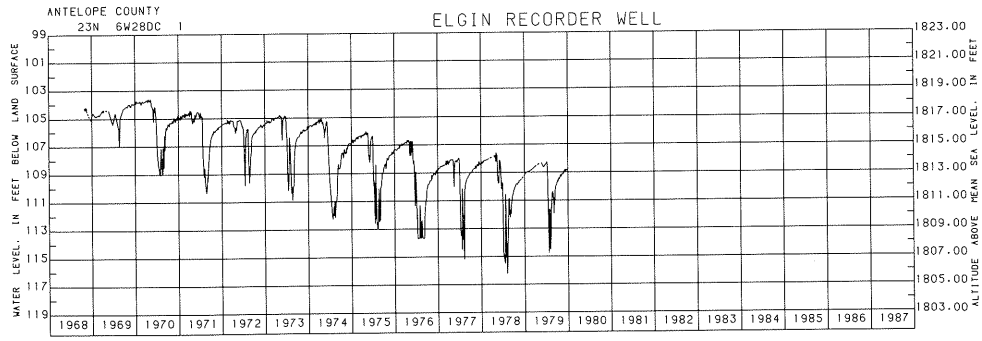
Areas of significant water-level change in the East North-Central Division from 1957 to fall 1979

Antelope County: Elgin

Estimated predevelopment water level: 102 ft (31.0 m)

Net water-level change in 1979: +0.48 ft (+0.146 m)

Average annual net water-level change since 1968: −0.38 ft (−0.116 m)

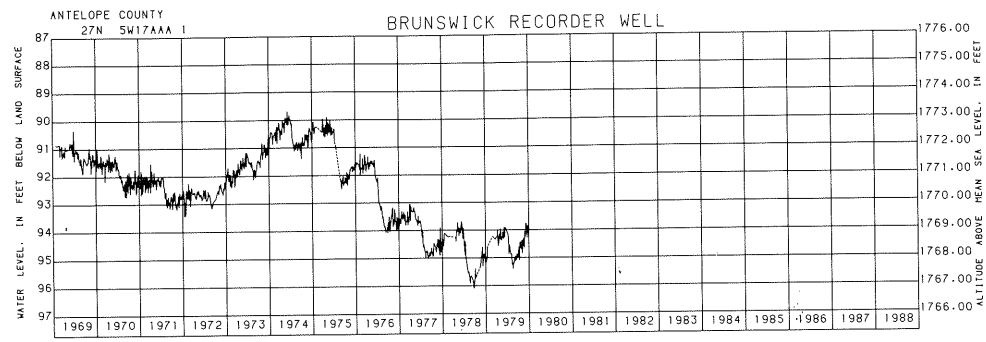


Antelope County: Brunswick

Estimated predevelopment water level: 90 ft (27.5 m)

Net water-level change in 1979: +1.43 ft (+0.435 m)

Average annual net water-level change since 1968: −0.27 ft (−0.082 m)

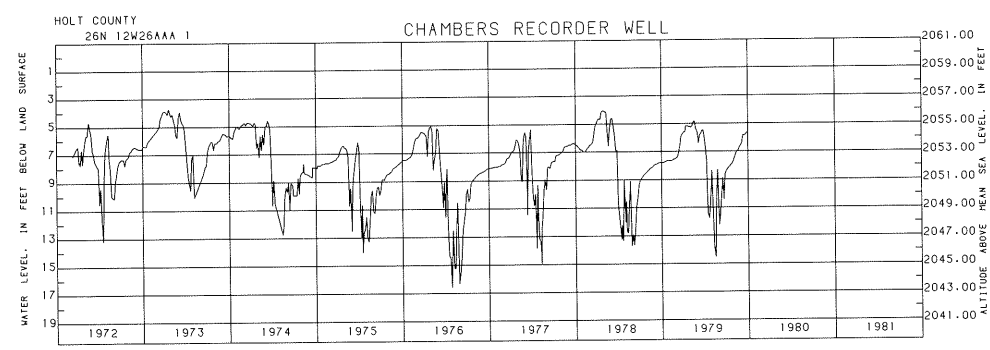


Holt County: Chambers

Estimated predevelopment water level: 6.0 ft (1.83 m)

Net water-level change in 1979: +2.22 ft (+0.68 m)

Average annual net water-level change since 1968: +0.12 ft (+0.036 5 m)

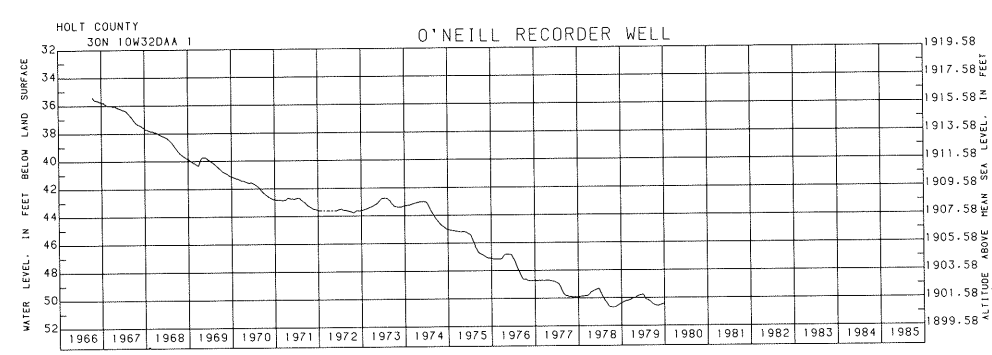


Holt County: O'Neill

Estimated predevelopment water level: 35 ft (10.7 m)

Net water-level change in 1979: −0.05 ft (−0.015 2 m)

Average annual net water-level change since 1966: −1.13 ft (−0.345 m)

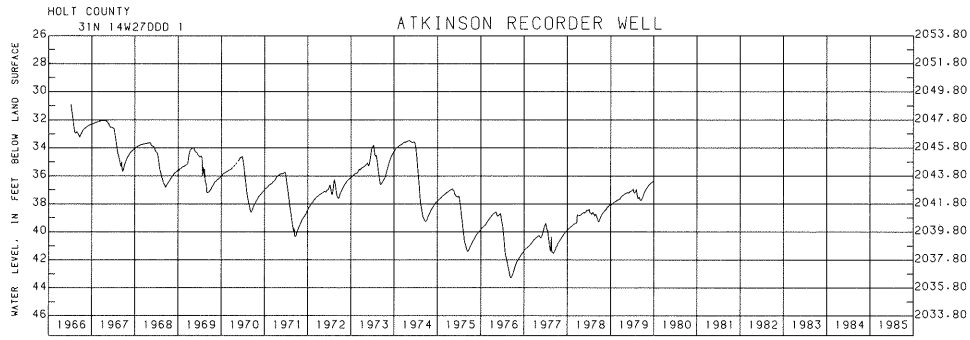


Holt County: Atkinson

Estimated predevelopment water level: 32 ft (9.8 m)

Net water-level change in 1979: +1.77 ft (+0.54 m)

Average annual net water-level change since 1966: −0.31 ft (−0.094 m)

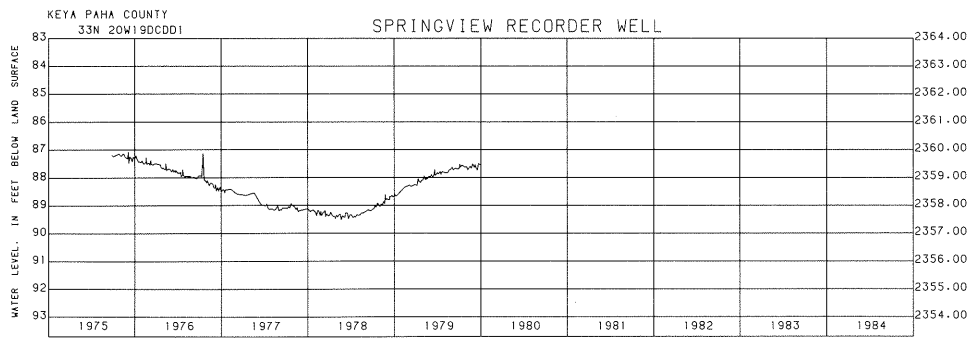


Keya Paha County: Springview

Estimated predevelopment water level: 91 ft (27.5 m)

Net water-level change in 1979: +1.17 ft (+0.355 m)

Average annual net water-level change since 1975: −0.06 ft (−0.018 3 m)



Southwest Division

The water level in most observation wells in the Southwest Division was higher in fall 1979 than in fall 1978, except in Dundy, Chase, and southern Perkins counties. The average water-level rise was approximately 0.5 ft (0.152 m) and the maximum rise—in Frontier County—was 10.95 ft (3.35 m). The small average rise in water levels, resulting from normal to above-normal precipitation in early spring and early summer, increased recharge to the aquifer and reduced the need for groundwater withdrawals for irrigation. Water-level declines in Dundy, Chase, and southern Perkins counties averaged 1.0 ft (0.305 m) and reflected the large withdrawals of groundwater for irrigation in these counties.

Water-level rises of 10 ft (3.05 m) or more from estimated predevelopment levels have occurred in an area of approximately 640,000 acres (2 600 km²) in Lincoln, eastern Perkins, and southeastern Keith counties. Water levels began rising in about 1940 as a result of deep percolation of water from Sutherland Reservoir, Lake Maloney, Jeffrey Reservoir, and their associated canals. The groundwater ridge thus created has a damming effect on groundwater moving toward it from the southwest. The ridge has also steepened the water-table gradient to the north and has increased the rate of groundwater discharge in the South Platte and Platte River valleys. Water levels have risen a little more than 38.0 ft (11.6 m) in two wells located in the uplands north of Dickens in Lincoln County. In the immediate vicinities of Sutherland Reservoir, Lake Maloney, and Jeffrey Reservoir, where data are incomplete, water-level rises of 50 ft (15.2 m) and more probably have occurred.

Approximate areas of significant water-level rises from estimated predevelopment water levels to fall 1979 were:

Amount of rise, in feet (meters, m)	Approximate area, in acres (square kilometers, km²)
10.00-20.00 (3.05-6.1)	369,000 (1 490)
20.00-50.00 (6.1-15.2)	236,000 (960)
50.00 or more (15.2 or more)	38,000 (154)

Estimated predevelopment water levels are approximately those prior to 1940. Historical data indicate that since the rise associated with development, water levels have fluctuated only slightly, generally in response to climatic factors that affect rates of recharge.

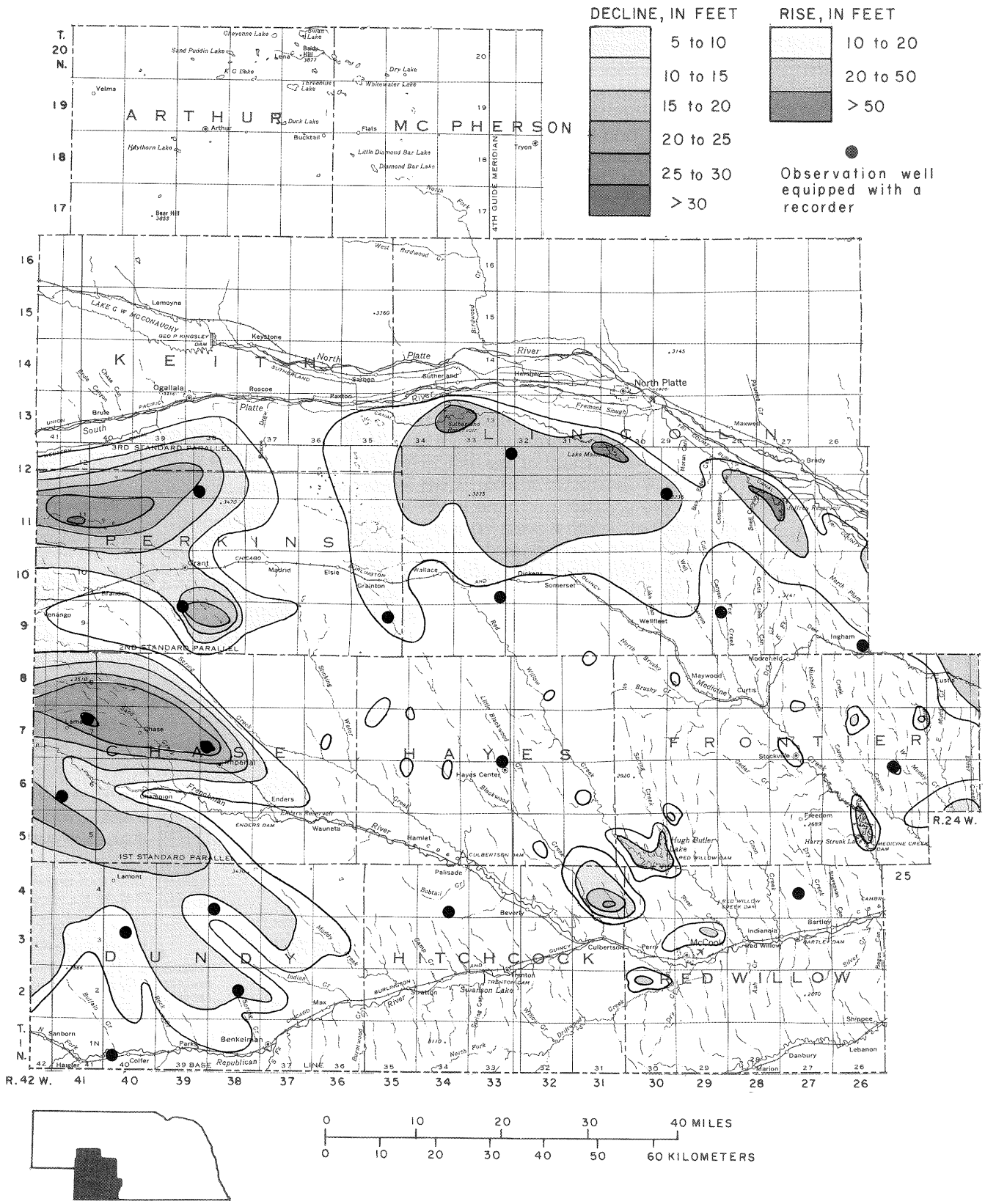
Surface-water impoundments in Frontier, Hayes, Hitchcock, and Red Willow counties have resulted in local water-level rises, but data are insufficient to delineate the areas of rise.

Water-level declines of 5 to 20 ft (1.52 to 6.1 m) have occurred in areas totaling 77,000 acres (310 km²) in Frontier, Hayes, and eastern Chase counties. A maximum decline of approximately 20 ft (6.1 m) since predevelopment occurred in a well east of Blackwood Creek in northeastern Hitchcock County. The declines reflect areas of intensive irrigation development.

Measurements in fall 1979 indicate that water-level declines of 5 ft (1.52 m) or more from estimated predevelopment levels have occurred in approximately 1.02 million acres (4 100 km²) in western Perkins, Chase, and Dundy counties. Declines range from 5 to 20 ft (1.52 to 6.1 m) in most of the area, but locally in Chase and northwestern Perkins counties they range from 25 to 34 ft (7.6 to 10.4 m).

In fall 1979 the approximate areas of water-level declines from estimated predevelopment water levels were:

Amount of decline, in feet (meters, m)	Approximate area, in acres (square kilometers, km²)
5.00-10.00 (1.52-3.05)	305,000 (1 230)
10.00-15.00 (3.05-4.55)	340,000 (1 380)
15.00-20.00 (4.55-6.1)	176,000 (710)
20.00-25.00 (6.1-7.6)	106,000 (430)
25.00-30.00 (7.6-9.1)	82,000 (330)
30.00 or more (9.1 or more)	3,950 (16.0)



Areas of significant water-level change in Southwest Division from 1940 to fall 1979

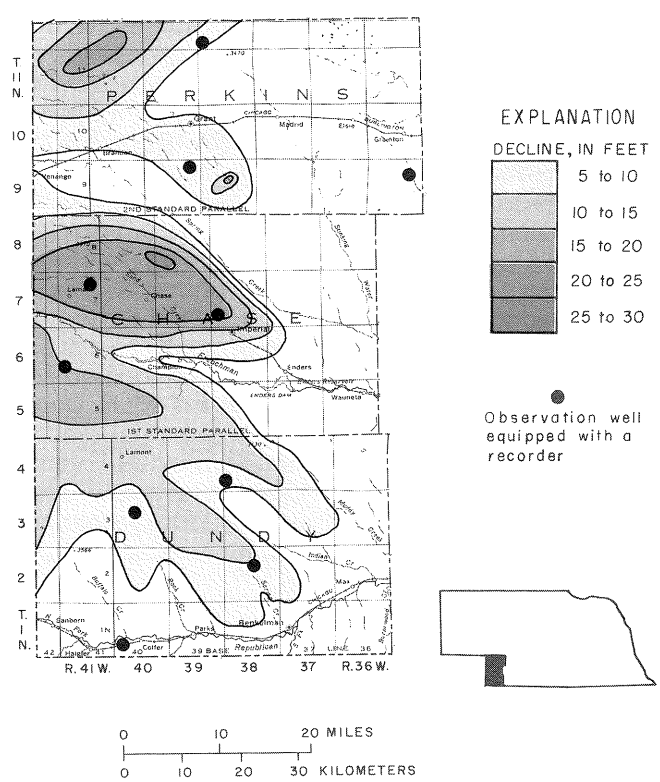
Estimated predevelopment water levels for wells in Perkins, Chase, and Dundy counties are the approximate water levels prior to 1953. Data are sufficient to make fairly good estimates of predevelopment water levels in most of the area, and measurements from existing observation wells provide adequate data for determination of current water-level changes.

In previous reports, the Grant South recorder well in south-central Perkins County showed a water-level rise of 34 ft (10.4 m) from estimated predevelopment level. The hydrograph for this well did not reflect seasonal fluctuations in water levels despite intensive irrigation development in the area, which indicated that the well was not in hydraulic connection with the principal aquifer. Redevelopment of the well in March 1979 resulted in a water-level response more consistent with the water-level responses in other wells nearby. On the basis of additional evidence of water-level declines of up to 15 ft (4.55 m) in the area, provided by the Upper Republican Natural Resources District, the small area in south-central Perkins County shown in previous reports as a water-level rise is now included in the larger water-level decline of this area.

Although periodic water-level measurements were made in only a few observation wells prior to 1974, available data indicate that a downward water-level trend started about 1966 and still continues as a result of the intensive groundwater development for irrigation. The spring 1979 water-level change map shows that declines of 5 ft or more from estimated predevelopment levels have depleted groundwater throughout an area of approximately 890,000 acres (3 600 km²).

Approximate areas of water-level declines from estimated predevelopment water levels in the spring of 1979 were:

Amount of decline, in feet (meters, m)	Approximate area, in acres (square kilometers, km²)
5.00-10.00 (1.52-3.05)	360,000 (1 460)
10.00-15.00 (3.05-4.55)	305,000 (1 230)
15.00-20.00 (4.55-6.1)	190,000 (770)
20.00-25.00 (6.1-7.6)	34,500 (140)
25.00 or more (7.6 or more)	3,900 (15.7)



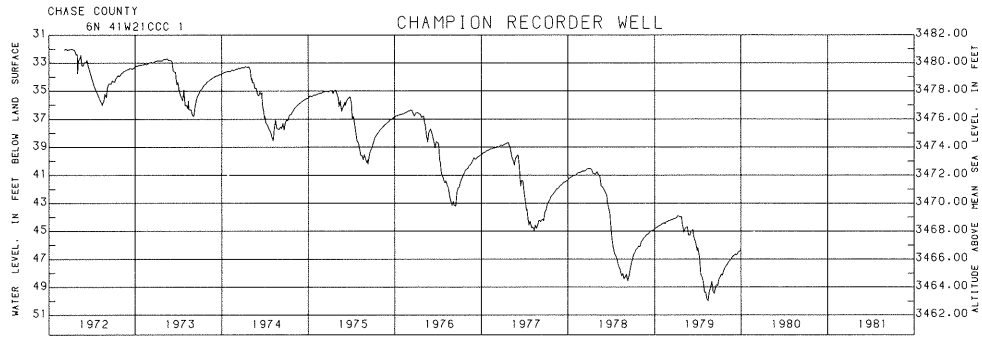
Areas of significant water-level change in Perkins, Chase, and Dundy counties from 1953 to spring 1979

Chase County: Champion

Estimated predevelopment water level: 30 ft (9.1 m)

Net water-level change in 1979: −1.53 ft (−0.456 m)

Average annual net water-level change since 1972: −1.87 ft (−0.57 m)

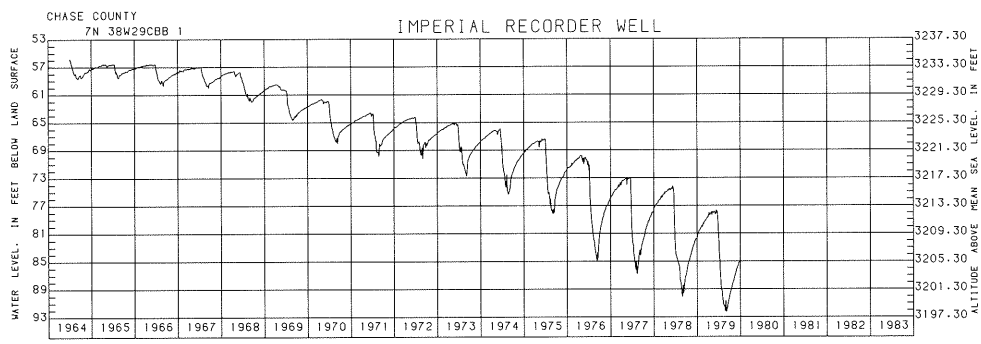


Chase County: Imperial

Estimated predevelopment water level: 56 ft (17.1 m)

Net water-level change in 1979: −2.79 ft (−0.85 m)

Average annual net water-level change since 1964: −1.82 ft (−0.55 m)

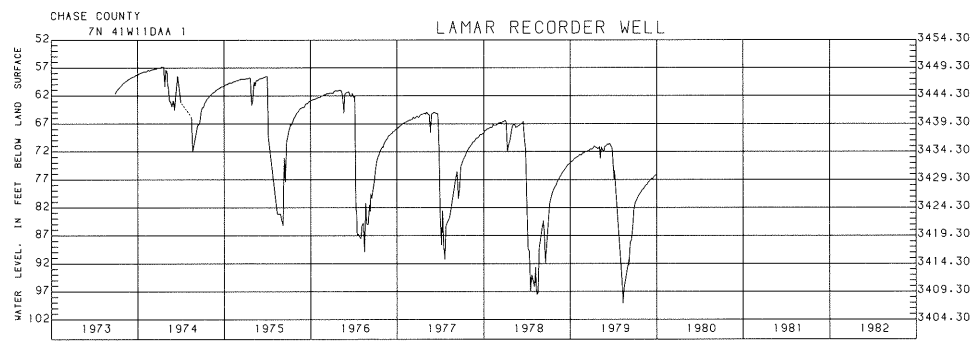


Chase County: Lamar

Estimated predevelopment water level: 50.5 ft (15.4 m)

Net water-level change in 1979: −2.00 ft (−0.61 m)

Average annual net water-level change since 1973: −2.95 ft (−0.90 m)

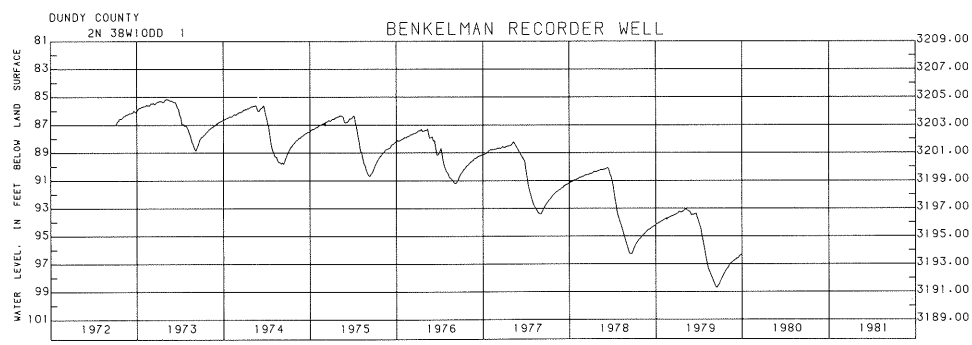


Dundy County: Benkelman

Estimated predevelopment water level: 84 ft (25.5 m)

Net water-level change in 1979: −2.12 ft (−0.65 m)

Average annual net water-level change since 1972: −1.47 ft (−0.450 m)

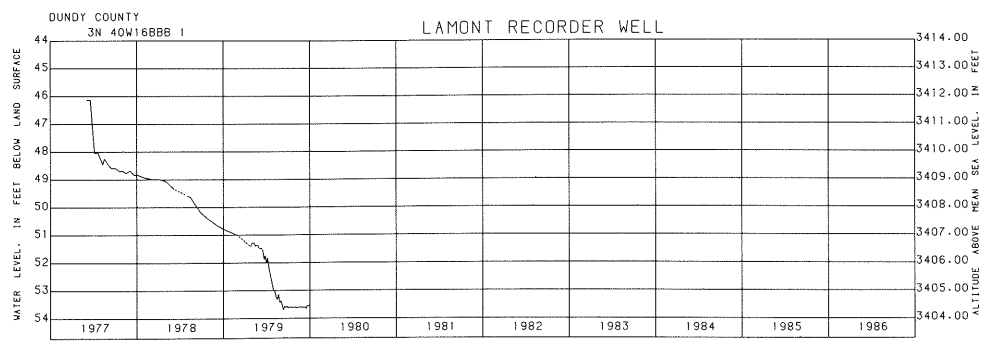


Dundy County: Lamont

Estimated predevelopment water level: Not determined

Net water-level change in 1979: −2.27 ft (−0.69 m)

Average annual net water-level change since 1977: −2.10 ft (−0.64 m)

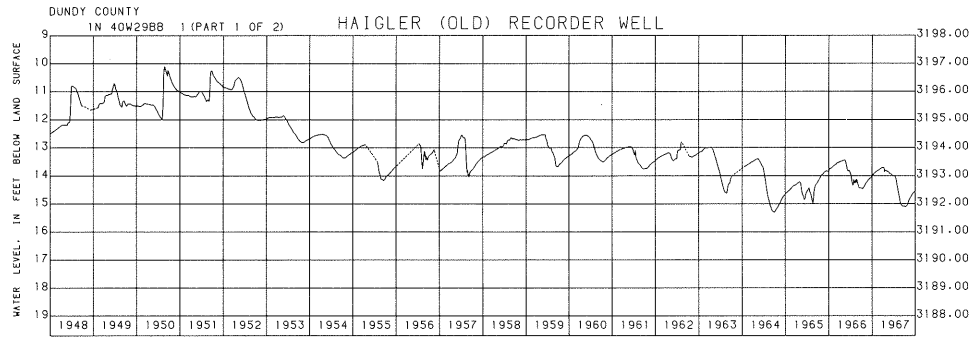


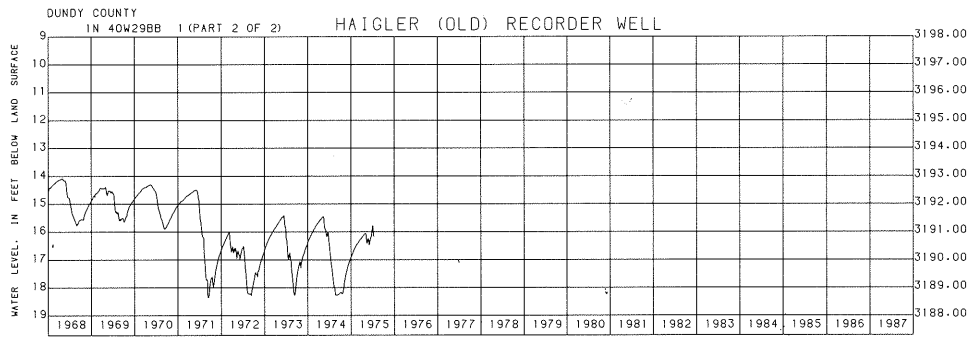
Dundy County: Haigler

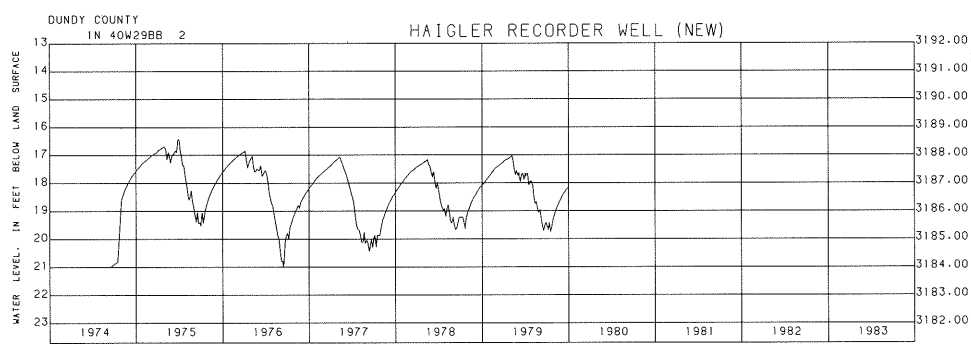
Estimated predevelopment water level: Old well, 12 ft (3.65 m); new well, 10 ft (3.05 m)

Net water-level change in 1979: −0.08 ft (−0.024 4 m)

Average annual net water-level change since 1948: Not significant; no long-term trend





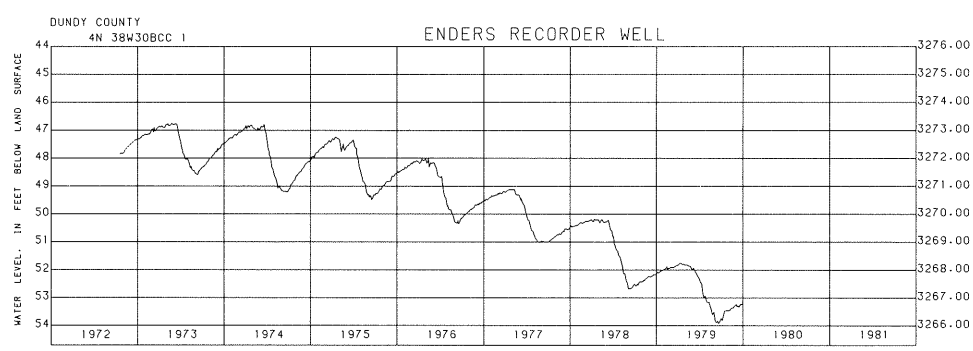


Dundy County: Enders

Estimated predevelopment water level: 46 ft (14.0 m)

Net water-level change in 1979: −1.06 ft (−0.325 m)

Average annual net water-level change since 1972: −0.84 ft (−0.255 m)

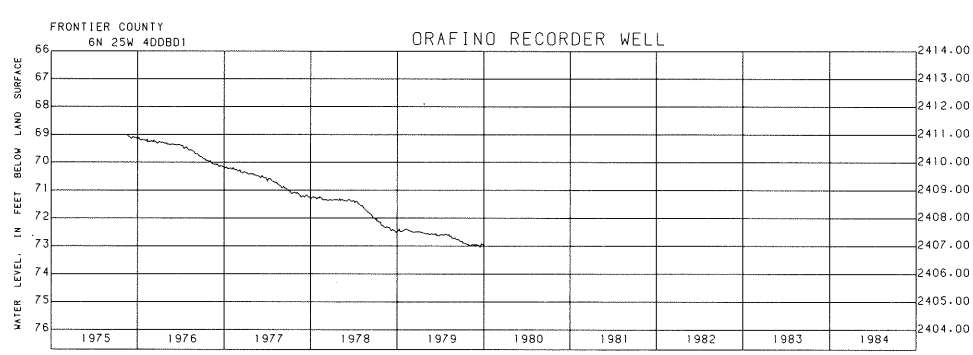


Frontier County: Orafino

Estimated predevelopment water level: 65 ft (19.8 m)

Net water-level change in 1979: −0.46 ft (−0.140 m)

Average annual net water-level change since 1975: −0.94 ft (−0.285 m)

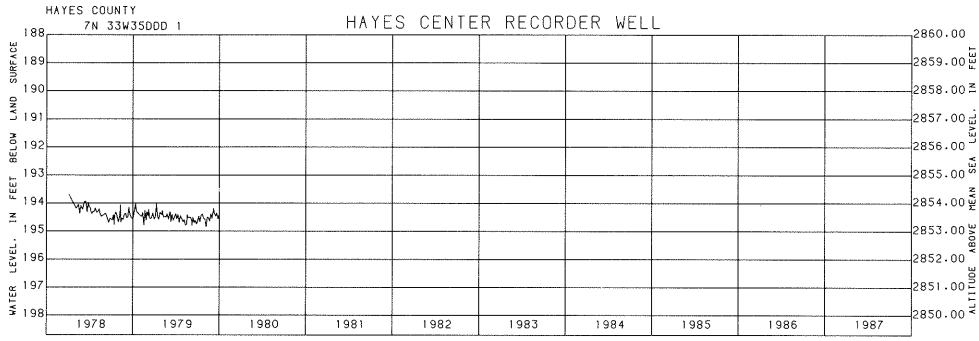


Hayes County: Hayes Center

Estimated predevelopment water level: 189 ft (58.0 m)

Net water-level change in 1979: +0.21 ft (+0.064 m)

Average annual net water-level change since 1978: +0.21 ft (+0.064 m)

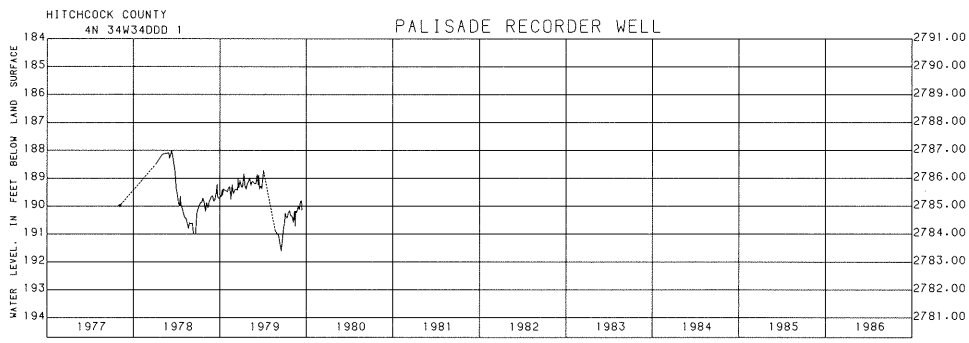


Hitchcock County: Palisade

Estimated predevelopment water level: 186 ft (57 m)

Net water-level change in 1979: Not determinable

Average annual net water-level change since 1978: Not determinable

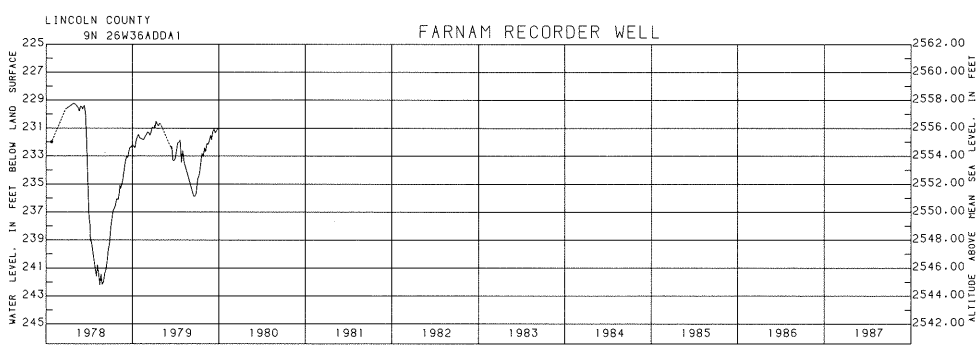


Lincoln County: Farnam

Estimated predevelopment water level: 243 ft (74 m)

Net water-level change in 1979: +1.09 ft (+0.330 m)

Average annual net water-level change since 1978: +1.09 ft (+0.330 m)

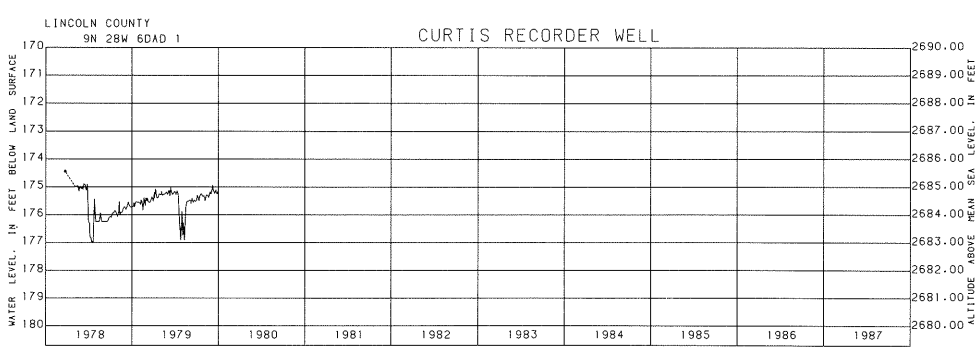


Lincoln County: Curtis

Estimated predevelopment water level: 169 ft (52 m)

Net water-level change in 1979: +0.65 ft (+0.198 m)

Average annual net water-level change since 1978: +0.65 ft (+0.198 m)

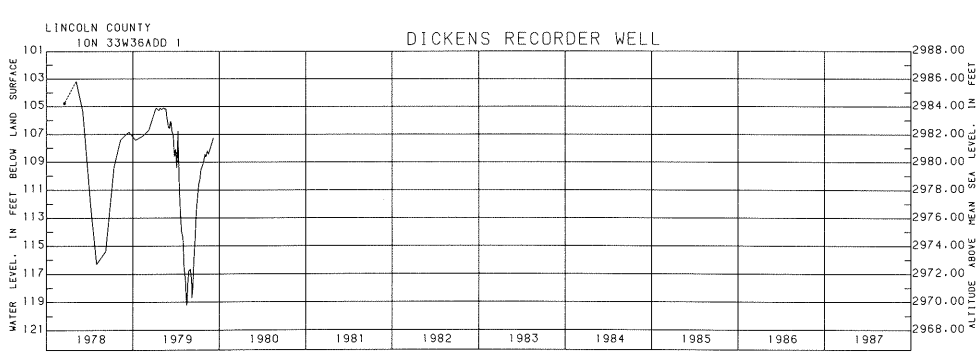


Lincoln County: Dickens

Estimated predevelopment water level: 108 ft (33.0 m)

Net water-level change in 1979: Not determinable

Average annual net water-level change since 1979: Not determinable

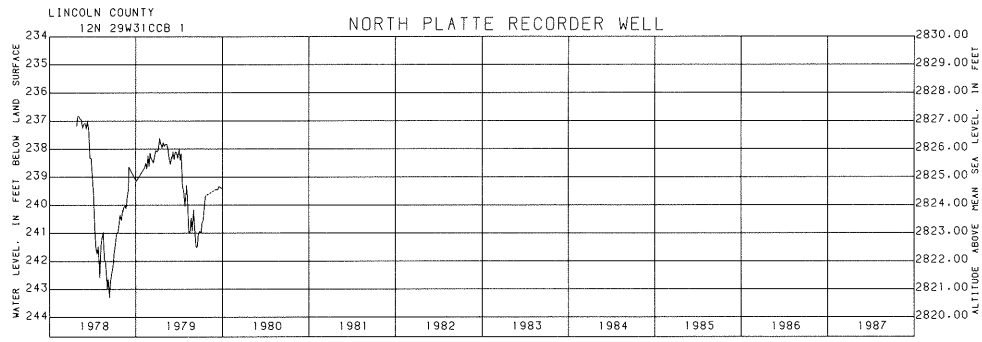


Lincoln County: North Platte

Estimated predevelopment water level: 271 ft (83 m)

Net water-level change in 1979: Not determinable

Average annual net water-level change since 1979: Not determinable

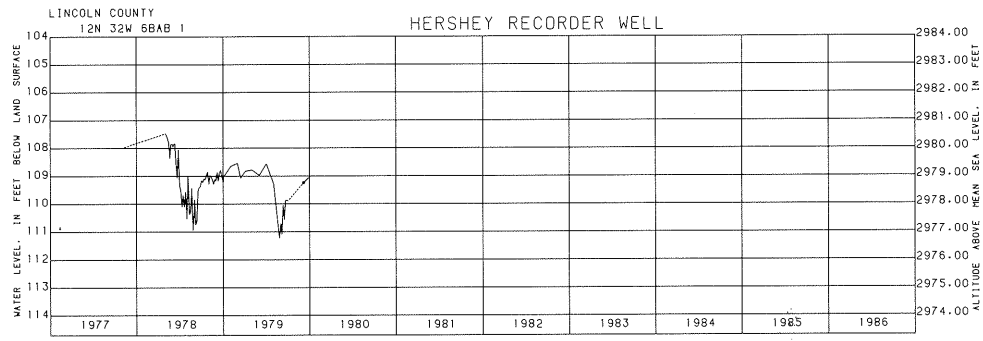


Lincoln County: Hershey

Estimated predevelopment water level: 131 ft (40.0 m)

Net water-level change in 1979: +0.23 ft (+0.070 m)

Average annual net water-level change since 1978: +0.23 ft (+0.070 m)

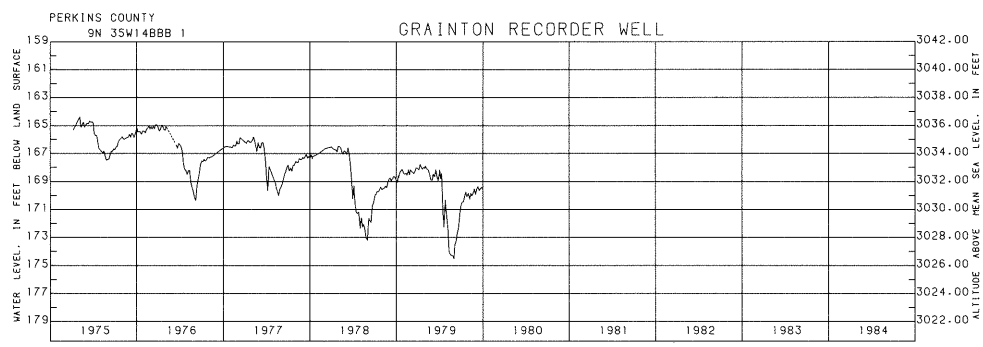


Perkins County: Grainton

Estimated predevelopment water level: 165 ft (50 m)

Net water-level change in 1979: −0.59 ft (−0.180 m)

Average annual net water-level change since 1975: −1.08 ft (−0.330 m)

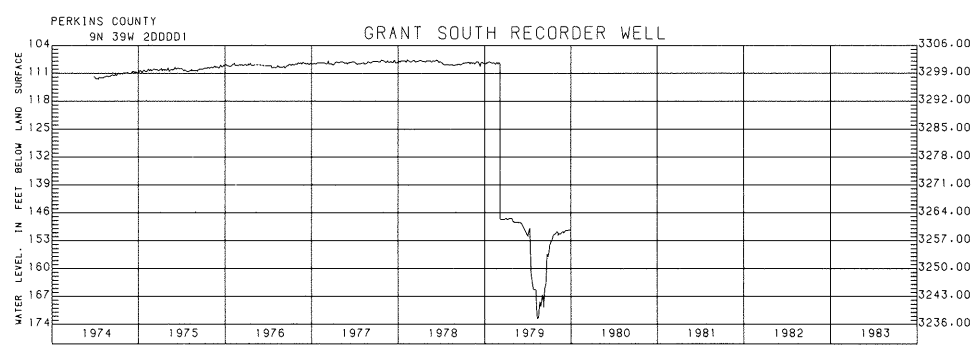


Perkins County: Grant South

Estimated predevelopment water level: 142 ft (43.5 m)

Net water-level change in 1979: Not determinable (well redeveloped in 1979)

Average annual net water-level change since 1974: Not determinable

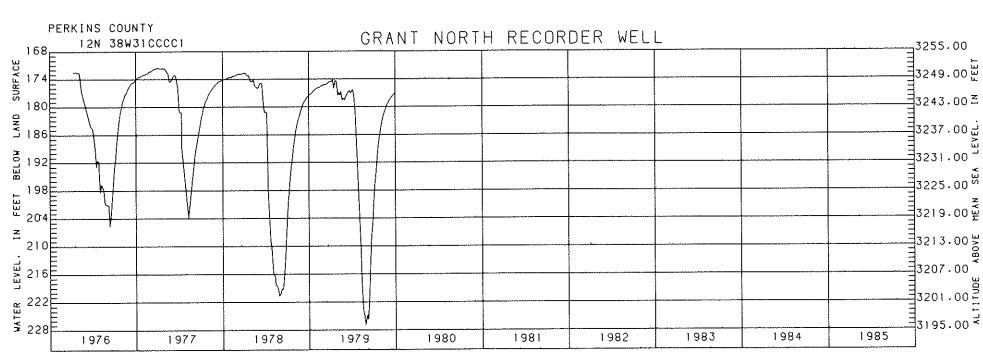


Perkins County: Grant North

Estimated predevelopment water level: 173 ft (53 m)

Net water-level change in 1979: +0.52 ft (+0.158 m)

Average annual net water-level change since 1976: −0.95 ft (−0.290 m)

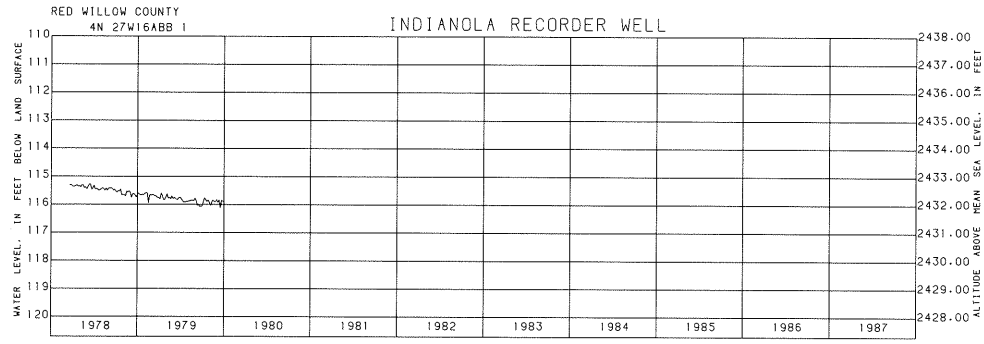


Red Willow County: Indianola

Estimated predevelopment water level: 115 ft (35.0 m)

Net water-level change in 1979: −0.24 ft (−0.073 m)

Average annual net water-level change since 1978: −0.24 ft (−0.073 m)



Long-term hydrograph of non-recorder well

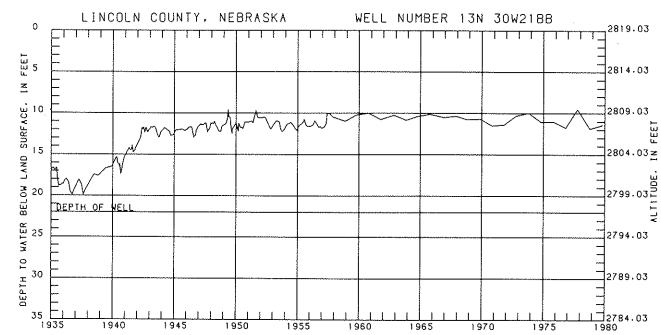
Lincoln County: 13N 30W 21BB1

Estimated predevelopment water level: 17.8 ft (5.4 m)

Highest water level: 9.51 ft (2.90 m), October 19, 1977

Lowest water level: 19.92 ft (6.07 m), September 17, 1936

Period of record: 1934—79

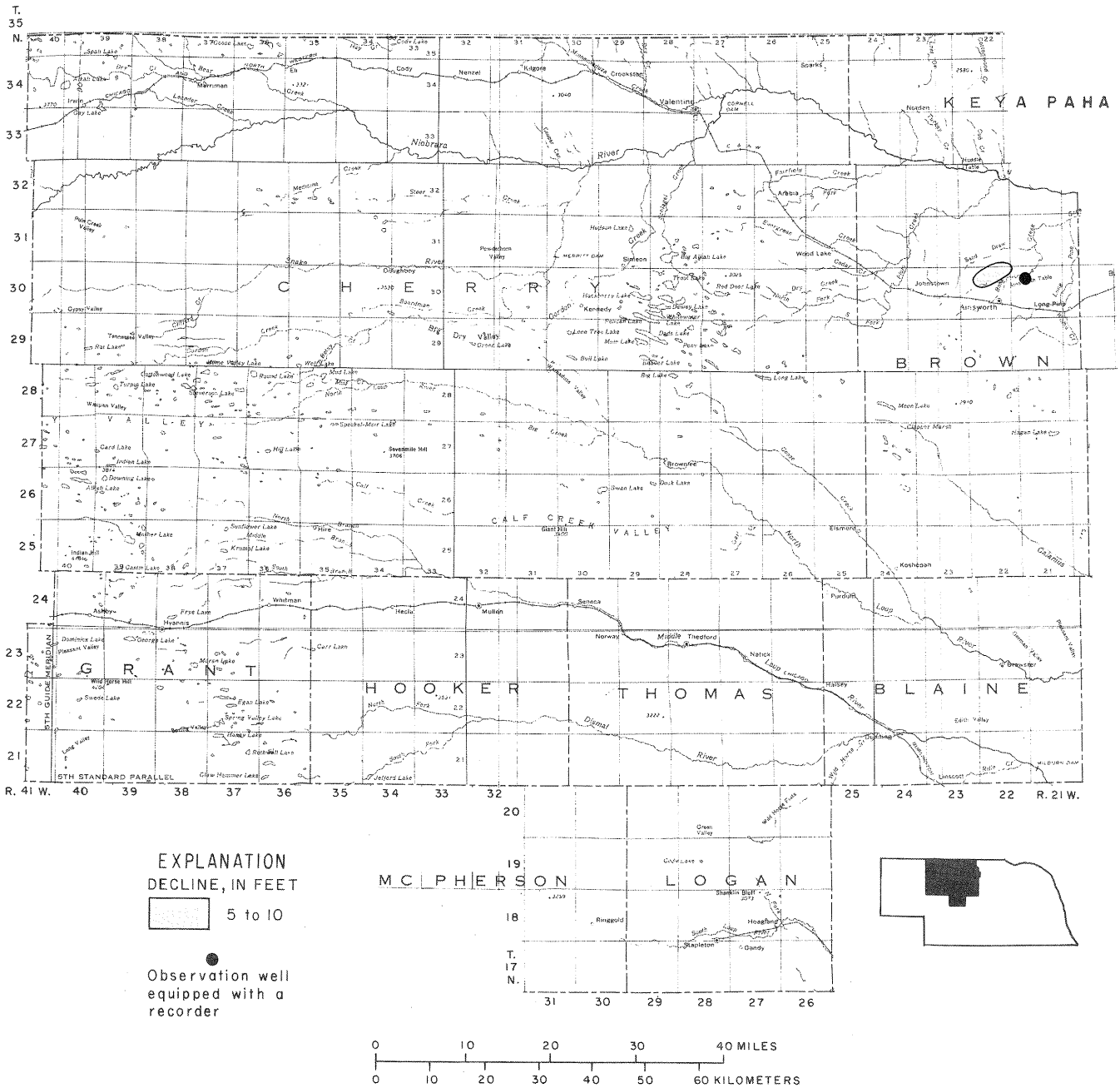


West North-Central Division

In the West North-Central Division during fall 1979, water levels in most wells were near to or slightly higher than those of fall 1978. Normal to above-normal precipitation occurred from early spring through the irrigation season, reducing the amount of groundwater needed for irrigation and increasing recharge to the aquifer.

Water-level data in this area are insufficient for determining any areas of long-term rises or declines, except for an area north of Ainsworth in Brown County. A maximum rise of 13 ft (4.00 m) from estimated predevelopment was recorded there in a well located 3 mi (4.80 km) north of Ainsworth in fall 1979.

Historical records indicate that withdrawals of groundwater for irrigation have not caused a significant lowering of water levels anywhere in this division. Although the number of irrigation wells installed and registered has increased from 76 to 1,185 in the 25-year period from 1954 to 1979, the average density of wells in the area is only 0.1 per square mile (0.260/km^2).



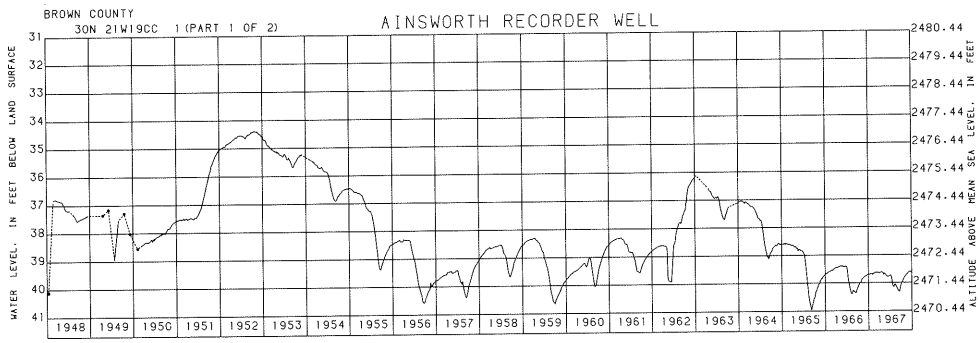
Areas of significant water-level change in the West North-Central Division from 1951 to fall 1979

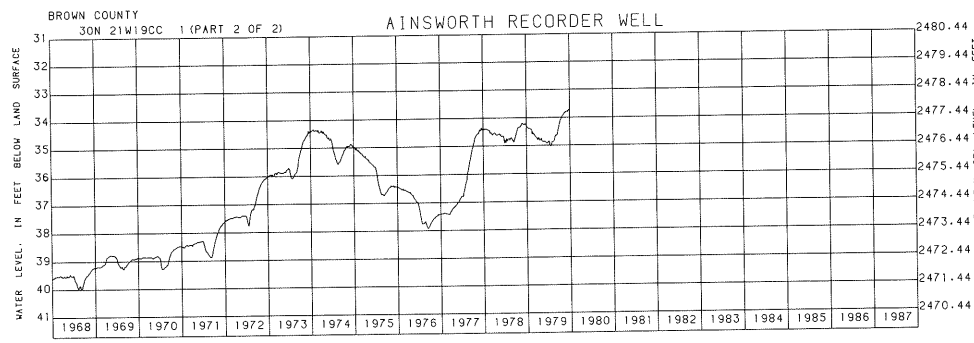
Brown County: Ainsworth

Estimated predevelopment water level: 36 ft (11.0 m)

Net water-level change in 1979: +0.52 ft (+0.158 m)

Average annual net water-level change since 1947: Not significant; no long-term trend





Long-term hydrographs of non-recorder wells

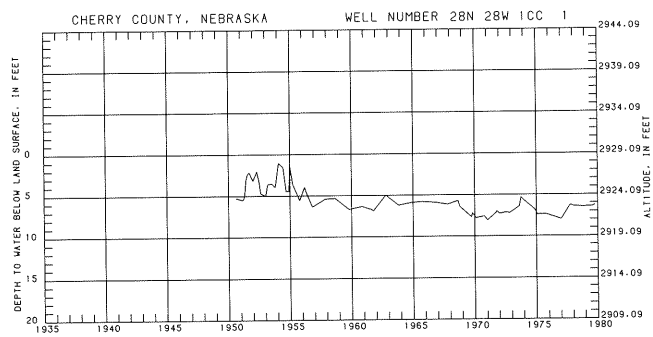
Cherry County: 28N 28W 1CC1

Estimated predevelopment water level: 4 ft (1.22 m)

Highest water level: 1.05 ft (0.320 m), February 5, 1954

Lowest water level: 8.10 ft (2.47 m), January 11, 1971

Period of record: 1950–79



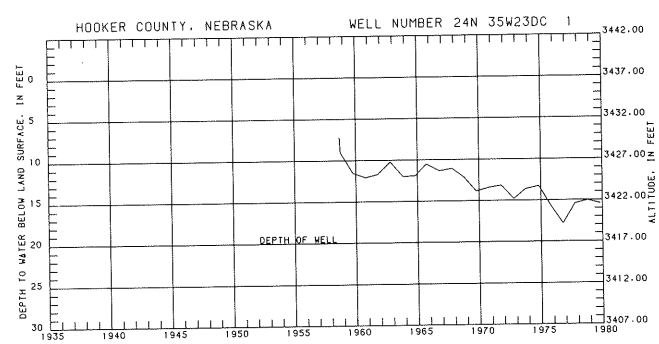
Hooker County: 24N 35W 23DC1

Estimated predevelopment water level: 4 ft (1.22 m)

Highest water level: 7.23 ft (2.20 m), September 4, 1958

Lowest water level: 17.84 ft (5.4 m), October 14, 1976

Period of record: 1958–78



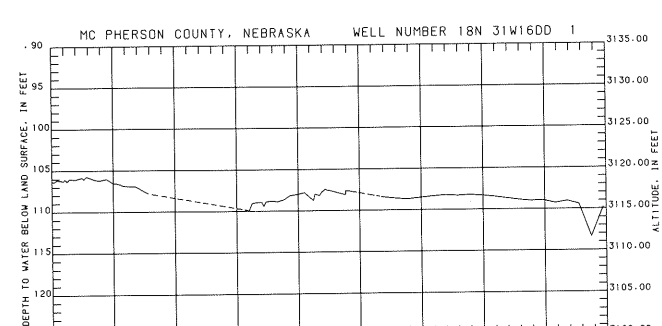
McPherson County: 18N 31W 6DD1

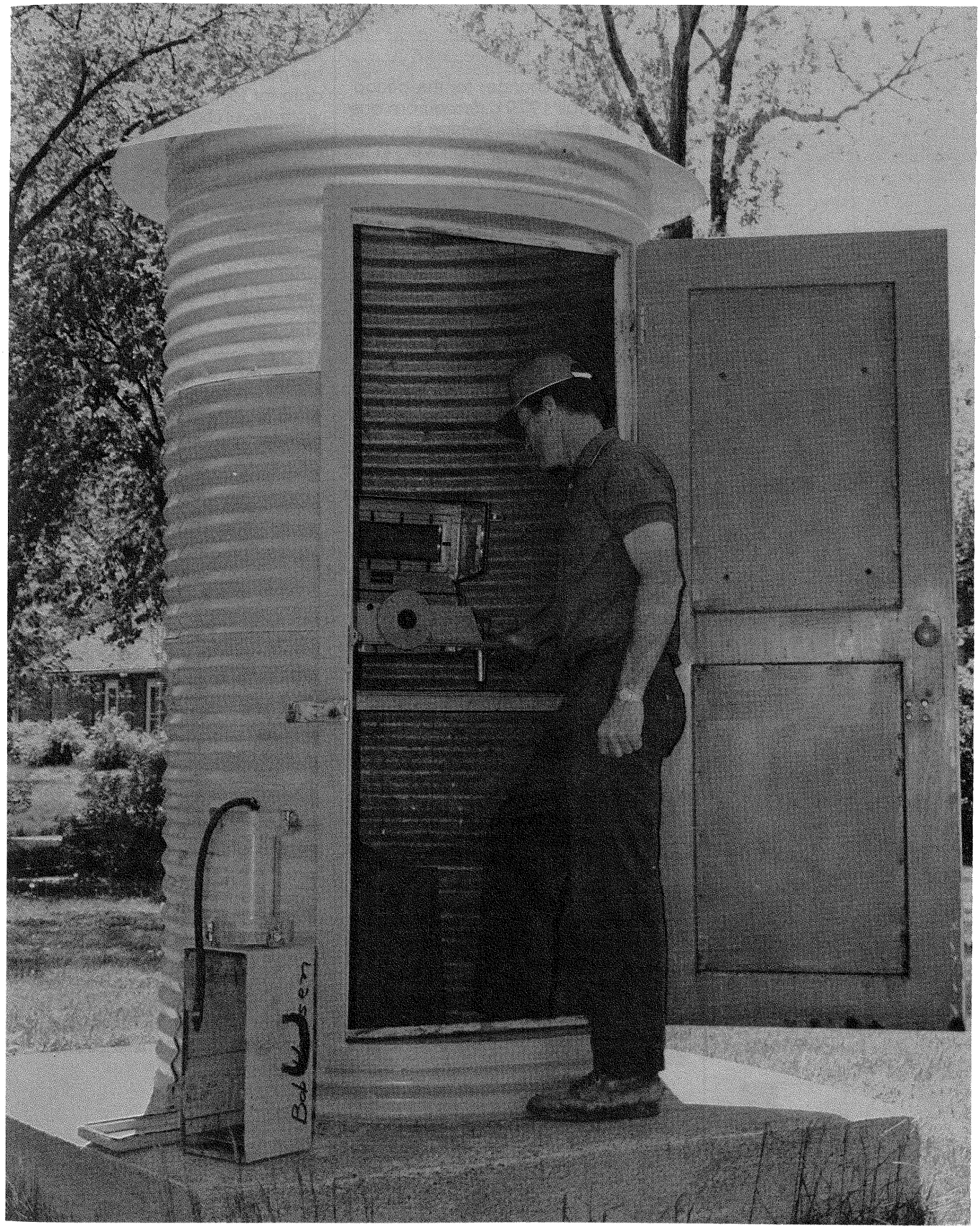
Estimated predevelopment water level: 108.8 ft (33.0 m)

Highest water level: 105.74 ft (32.0 m), October 17, 1937

Lowest water level: 113.38 ft (34.5 m), October 16, 1978

Period of record: 1934–42, 1951–59, 1961–76, 1978–79





Panhandle Division

Net water-level changes for the period fall 1978 to fall 1979 differed from one part of the Panhandle Division to another. In most observation wells in the north half, water levels declined; in most wells in the south, they rose. Declines averaged about 0.5 ft (0.152 m) in Box Butte, Dawes, Sheridan, and Sioux counties, with the maximum measured decline—2.18 ft (0.7 m)—occurring in west-central Sheridan County. Net water-level rises in the southern half of the Panhandle Division averaged about 1 ft (0.305 m). The maximum measured rise of 5 ft (1.52 m) occurred in a well north of Bridgeport in Morrill County.

Water levels have declined significantly since predevelopment in two major areas in the Panhandle as a result of intensive groundwater development for irrigation. The first major area is in Box Butte County north of Alliance where pumpage for irrigation has caused progressive water-level declines that began about 1950. Declines of 5 ft (1.52 m) or more have occurred in an area of about 177,000 acres (720 km²) and a maximum decline of over 50 ft (15.2 m) has been recorded in an observation well about 3 mi (4.80 km) north of Alliance.

As of fall 1979, the approximate areas of significant water-level declines from estimated predevelopment water levels in Box Butte County were as follows:

Amount of decline, in feet (meters, m)	Approximate area, in acres (square kilometers, km²)	
5.00-10.00 (1.52-3.05)	44,000	(178)
10.00-15.00 (3.05-4.55)	42,500	(172)
15.00-20.00 (4.55-6.1)	37,500	(152)
20.00-25.00 (6.1-7.6)	25,000	(101)
25.00-30.00 (7.6-9.1)	21,000	(85)
30.00 or more (9.1 or more)	7,700	(31.0)

Approximate water levels prior to 1947 are used as the estimated predevelopment water levels in Box Butte County.

Sufficient data are available for good estimates of predevelopment water levels and existing water-level measurement programs provide sufficient data for fairly good definition of current water-level changes in most of the area.

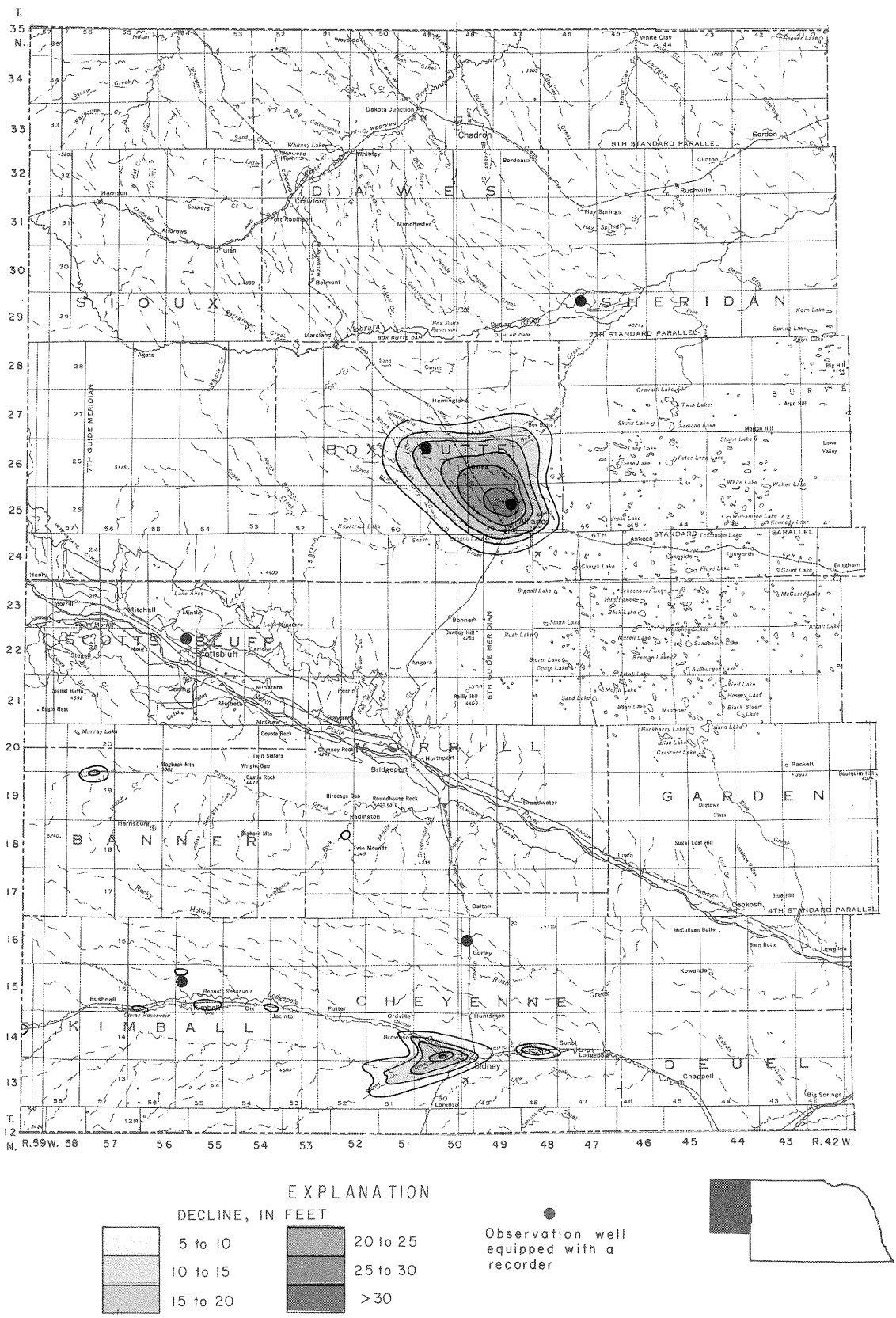
The second major area of significant water-level declines since predevelopment is along Lodgepole Creek valley and Sidney Draw in Cheyenne County. Groundwater withdrawals for irrigation and below-normal precipitation have resulted in progressively declining water levels since 1969. Declines of 5 ft (1.52 m) or more have occurred in an area of approximately 51,000 acres (206 km²). A maximum decline of 30.9 ft (9.4 m) from estimated predevelopment level has been recorded in an observation well in Lodgepole Creek valley west of Sidney.

In fall 1979 the approximate areas of significant water-level declines from estimated predevelopment water levels were as follows:

Amount of decline, in feet (meters, m)	Approximate area, in acres (square kilometers, km²)	
5.00-10.00 (1.52-3.05)	27,500	(111)
10.00-15.00 (3.05-4.55)	12,900	(52)
15.00-20.00 (4.55-6.1)	8,500	(34.0)
20.00-25.00 (6.1-7.6)	1,790	(7.2)
25.00 or more (7.6 or more)	385	(1.55)

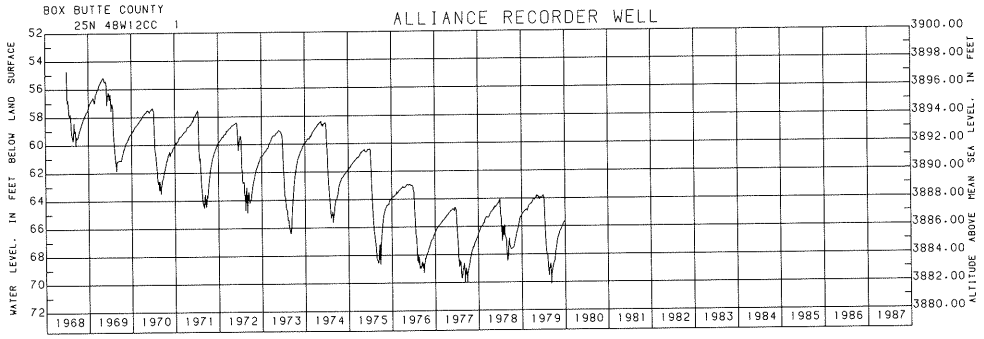
Estimated predevelopment water levels in the area are the approximate water levels prior to 1950.

Water-level declines of more than 5 ft (1.52 m) from estimated predevelopment levels have occurred also in areas along Lodgepole Creek in Kimball County and along Pumpkin Creek in Banner County. Available data are not sufficient for accurate delineation of the areas of decline in these counties.

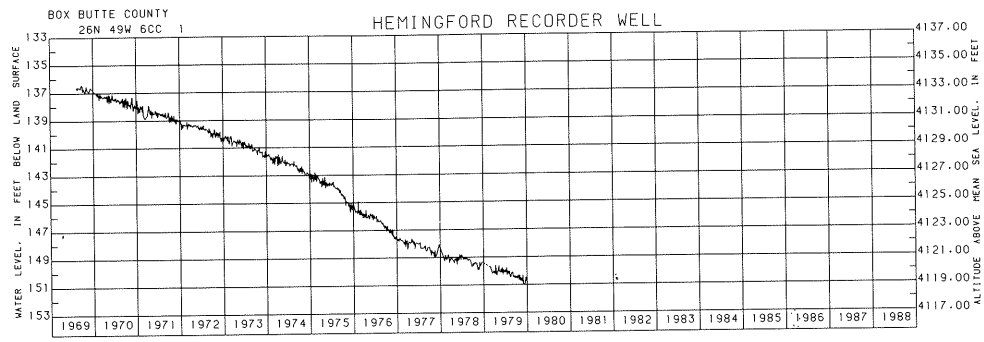


Areas of significant water-level change in the Panhandle Division from 1946 to fall 1979

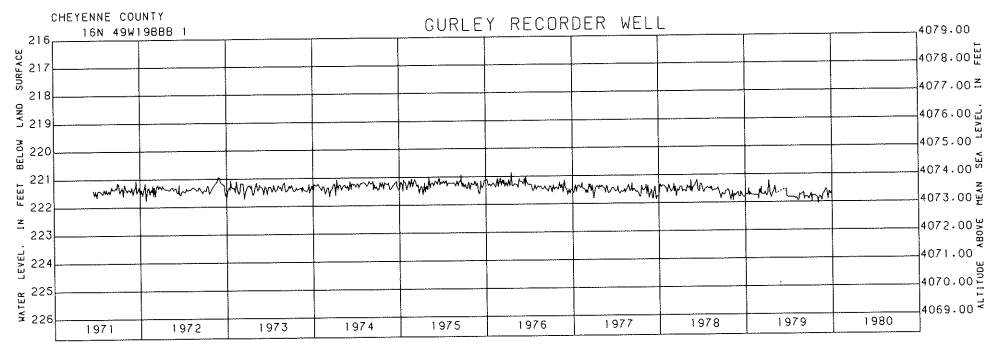
Box Butte County: Alliance
Estimated predevelopment water level: 17 ft (5.2 m)
Net water-level change in 1979: −0.58 ft (−0.177 m)
Average annual net water-level change since 1968: −0.77 ft (−0.235 m)



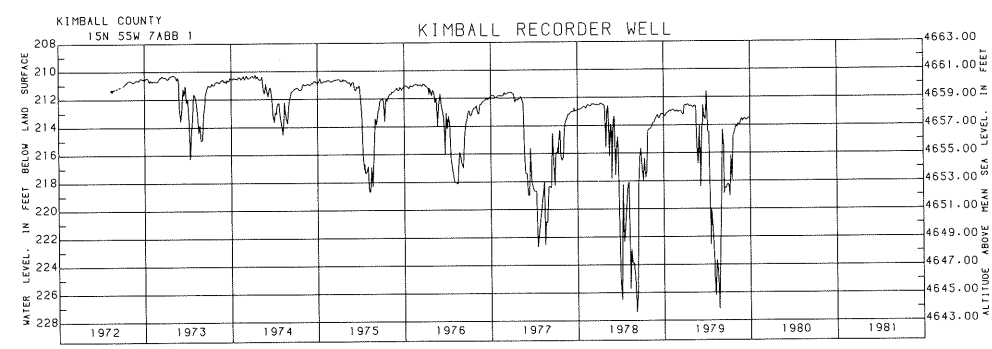
Box Butte County: Hemingford
Estimated predevelopment water level: 134 ft (41.0 m)
Net water-level change in 1979: Not determinable
Average annual net water-level change since 1968: −1.39 ft (−0.425 m)



Cheyenne County: Gurley
Estimated predevelopment water level: 221 ft (67 m)
Net water-level change in 1979: +0.13 ft (+0.039 5 m)
Average annual net water-level change since 1971: Not determinable; no long-term trend established



Kimball County: Kimball
Estimated predevelopment water level: 210 ft (64 m)
Net water-level change in 1979: −0.24 ft (−0.073 m)
Average annual net water-level change since 1972: −0.40 ft (−0.122 m)

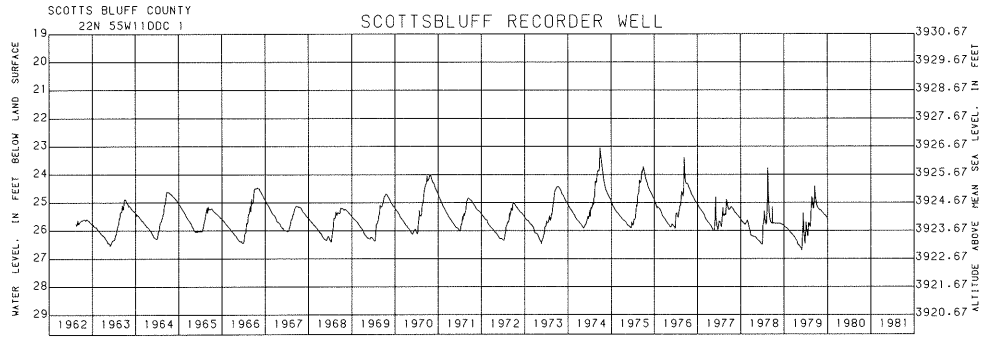


Scotts Bluff County: Scottsbluff

Estimated predevelopment water level: 26 ft (7.9 m)

Net water-level change in 1979: +0.27 ft (+0.082 m)

Average annual net water-level change since 1962: Not significant; no long-term trend established

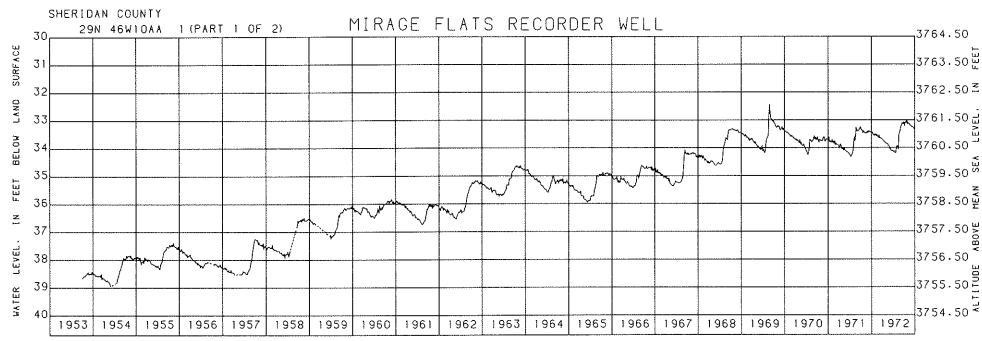


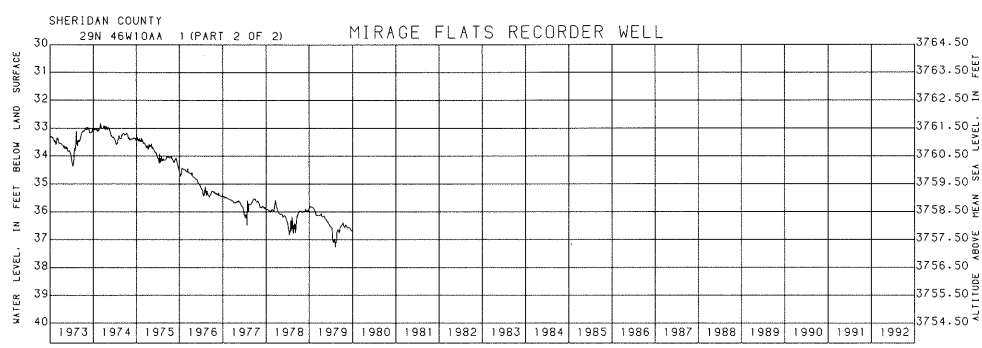
Sheridan County: Mirage Flats

Estimated predevelopment water level: 38.5 ft (11.7 m)

Net water-level change in 1979: −0.94 ft (−0.285 m)

Average annual net water-level change since 1953: +0.07 ft (+0.021 3 m)





Long-term hydrograph of non-recorder well

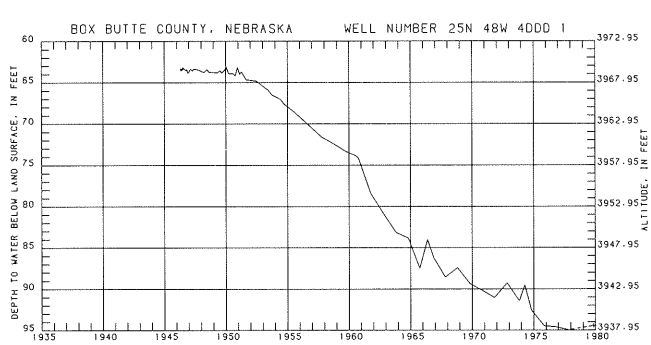
Box Butte County: 25N 48W 4DDD1

Estimated predevelopment water level: 63 ft (19.2 m)

Highest water level: 63.14 ft (19.2 m), January 25, 1950

Lowest water level: 94.97 ft (29.0 m), October 21, 1977

Period of record: 1946—79



WATER-LEVEL MEASUREMENT PROGRAM, 1979

Location of Observation Wells and Availability of Data

Thirty-two agencies collected water-level measurements in Nebraska, which serve as basic data for this report.

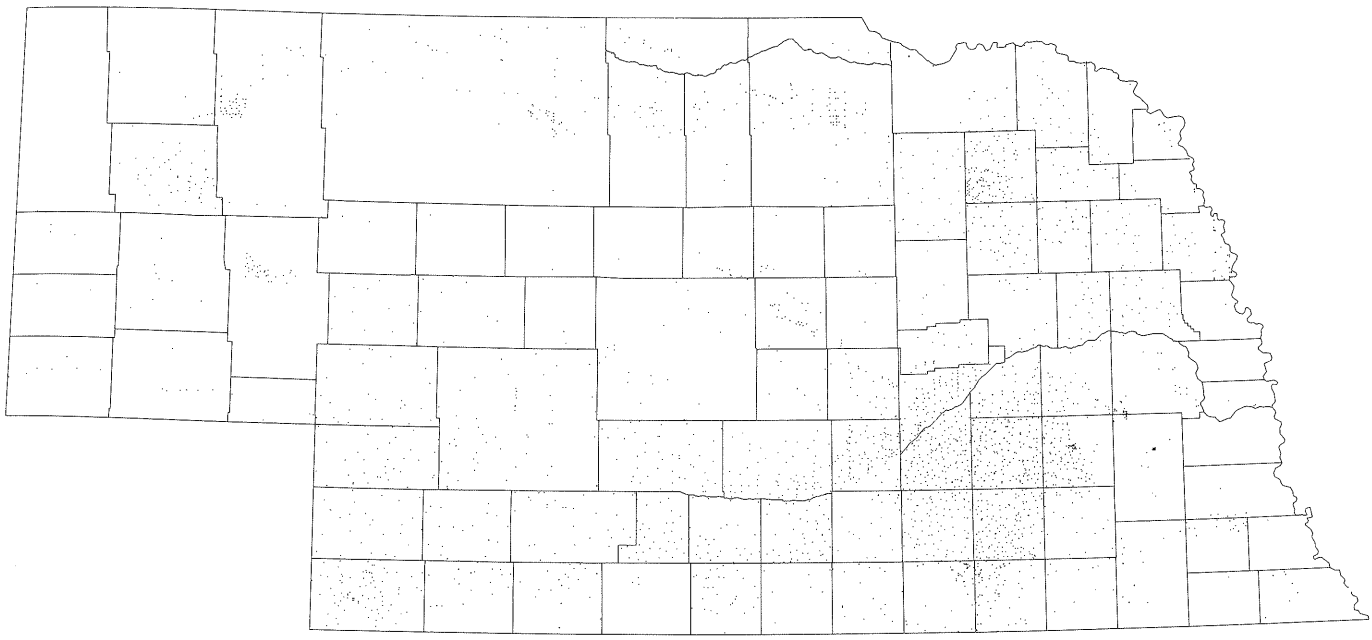
Observation-well networks operated by 32 different agencies and associations provide the water-level data used in preparing this report. Water-level measurements are made for a variety of needs, which helps to explain the nonuniform distribution of observation wells in the state. The number of observation wells per county ranges from one or two in several counties to more than 100 in others, with the greatest density in areas where changes in water levels have been significant.

Locations of all observation wells from which data were used in the preparation of this report are shown on the accompanying map. Measurements made in these wells are included in a computerized file of historical water-level records maintained by the U.S. Geological Survey and the Conservation and Survey Division. Records of water-level measurements included in the file may be obtained, upon request, from the U.S. Geological Survey, Room 406, Federal Building, 100 Centennial Mall/North, Lincoln, Nebraska 68508; or from the Conservation and Survey Division, University of Nebraska, 113 Nebraska Hall, Lincoln, Nebraska 68588.

As part of the cooperative groundwater investigation program of the U.S. Geological Survey and the Conservation and Survey Division, a statewide water-level measurement program was begun in 1930. Initially this program consisted of an observation-well network to provide long-term data on changes in the amount of groundwater in storage and to detect areas where changes in water levels indicated problems might occur. The original observation-well network was designed to provide data for only a generalized appraisal of the state's groundwater resources. In time, a need to obtain detailed water-level data for specific areas led to the establishment of a number of local observation-well networks.

The need for water-level data to use in planning and evaluating the development of Nebraska's groundwater resources has changed the original cooperative water-level measurement program considerably. Currently the program provides not only for the operation of a statewide observation-well network but also for assistance and advice to other agencies and associations in the establishment and operation of local observation-well networks, the operation and maintenance of a computer storage-and-retrieval system for water-level data from all networks, and the evaluation and dissemination of water-level data.

The cooperation and assistance of the following agencies and associations in collecting and providing water-level data during 1979 is gratefully acknowledged: Water and Power Resources Service; U.S. Fish and Wildlife Service; Nebraska Department of Water Resources; Big Blue River Compact Administration; Lower Republican, Middle Republican, Upper Republican, Upper Big Blue, Little Blue, Lower Platte North, Central Platte, Twin Platte, North Platte, South Platte, Lower Niobrara, Middle Niobrara, Upper Niobrara-White, Lower Loup, Upper Loup, Lower Elkhorn, Upper Elkhorn, Middle Missouri Tributaries, Lewis and Clark, Nemaha, and Tri-Basin Natural Resources Districts; Central Nebraska Public Power and Irrigation District; South-Central Nebraska Pump Irrigators Association; Clay County, Fillmore County, Hamilton County, Seward County, and York County Ground Water Conservation Districts; Harlan and Franklin County Agents; Omaha Municipal Utilities District; and Lincoln Water System.



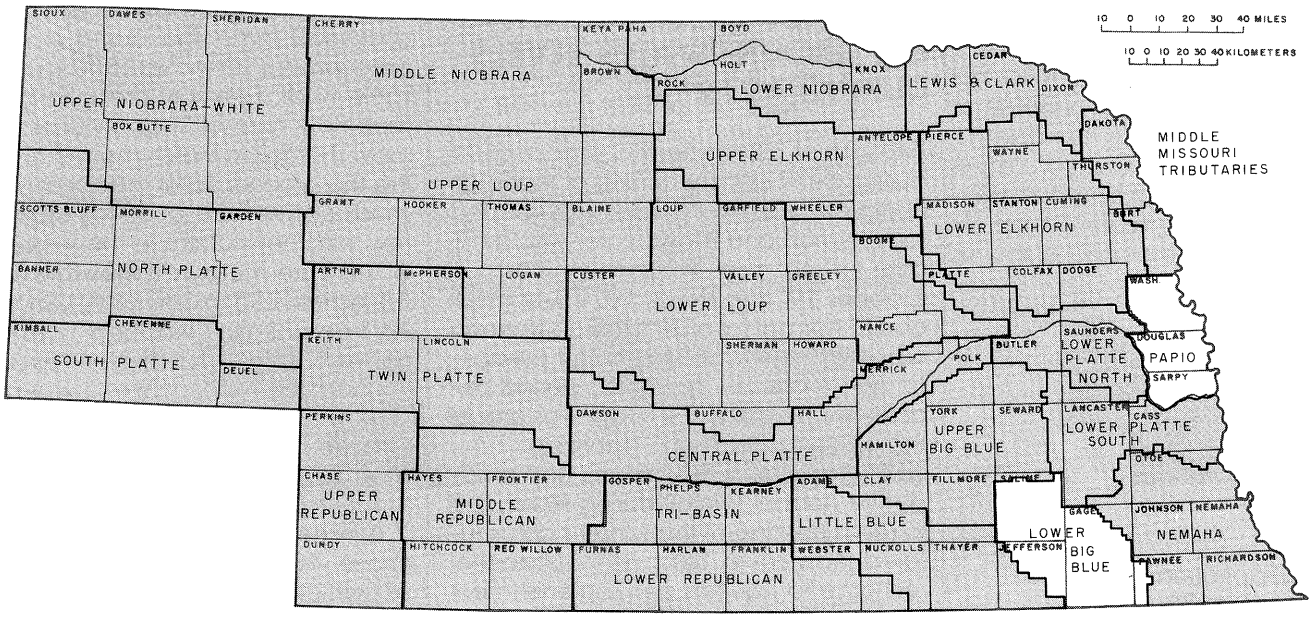
Location of water-level observation wells in Nebraska

Changes in Program And Other Activities During 1979

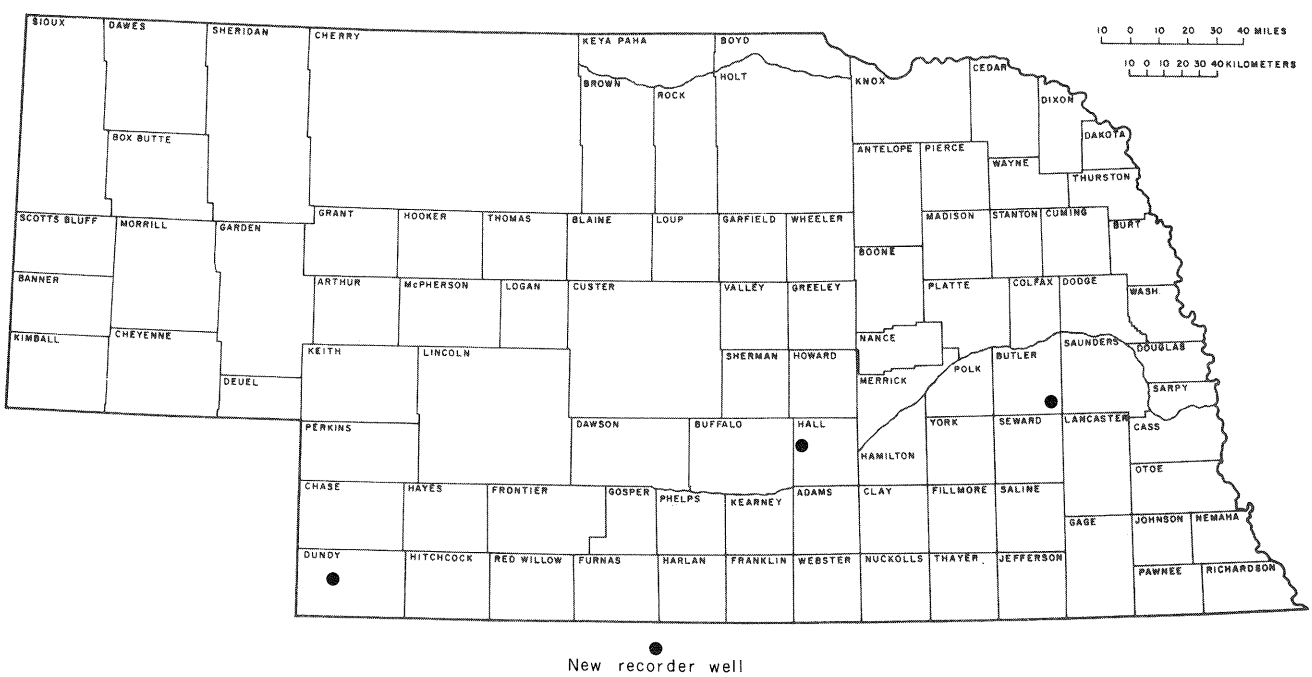
Three new continuous-recording observation wells were added to the water-level-measurement program in 1979. Recorders were installed and operation begun in Dundy and Hall counties where pumping for irrigation is significantly affecting water levels. A well was drilled and a recorder installed in Butler County to replace a well in which the casing apparently had collapsed. Hydrographs for these new recorder wells are included in the appropriate sections of this report.

Other activities of the water-level program included inspection and replacement of destroyed and nonfunctioning wells. Small-diameter observation wells in Butler, Colfax, Custer, Dawson, Hamilton, Merrick, Nance, and Platte counties were inspected and cleaned or replaced as needed. These measures were taken to ensure the continuity of long-term records and the quality of data in the computer file.

No new observation-well networks were established in 1979 because the networks established in previous years provide sufficient data for evaluating the significance of water-level changes where groundwater development for irrigation is taking place. As groundwater-data needs change, and as the development of groundwater for irrigation in the state increases, observation-well networks established in previous years require review and revision. To any agency requesting it, the Conservation and Survey Division and the U.S. Geological Survey provide assistance in evaluating and updating local observation-well networks.



Natural Resources Districts having a network of observation wells, fall 1979



Location of water-level recorder wells installed in 1979

EFFECT OF PRECIPITATION ON GROUNDWATER LEVELS DURING 1979

Because precipitation was above normal during 1979, less groundwater was needed for irrigation and more water was available for recharge.

Because of above-normal precipitation during 1979 and the timing of that precipitation, less groundwater was needed for irrigation and more water was available for recharge. Precipitation from October 1978 to March 1979 was much above normal for all Nebraska's National Weather Service divisions. Most precipitation fell as snow during this period because the winter of 1978-79 was one of the coldest recorded in Nebraska. Above-normal temperatures and much above normal rainfall during March led to rapid melting of the winter's accumulated snow cover, resulting in substantial recharge to aquifers and replenishment of soil moisture. Water-level rises were recorded in many observation wells. These rises continued until the start of the irrigation season, which was later than usual in many areas because of ample soil-moisture supplies maintained by above-normal precipitation in many of Nebraska's National Weather Service divisions during April and May. Above-normal precipitation during July in five of the eight weather divisions further reduced irrigation needs. During September, below-normal precipitation occurred in all Nebraska's National Weather Services divisions except the North Central Division where slightly above normal rainfall was measured. Soil moisture levels were rapidly restored by the above-normal to much above normal precipitation that occurred during October and November. Precipitation during 1979 was normal to slightly above normal for all Nebraska's National Weather Service divisions.

The following is a more detailed description of the succession of weather events during 1979, as excerpted from preliminary monthly reports prepared by the Center for Agricultural Meteorology and Climatology, Institute of Agriculture and Natural Resources, the University of Nebraska–Lincoln.

Snowfall amounts during January generally ranged from 5 to 19 inches (127 to 480 mm) statewide, with Sterling, Falls City, and Nebraska City reporting 21 inches (530 mm). The largest reported amount was 23 inches (580 mm) at Table Rock. February precipitation was far below normal in all divisions. Most snow that fell in March melted on reaching the ground. Total precipitation was much above normal during March. A few weather stations in the western half of the state measured snowfalls of 10 to 15 inches (255 to 380 mm) during April. April precipitation was near normal or above normal in all divisions except the Panhandle Division where it was 65 percent of normal. Precipitation amounts differed greatly over the state during May. Reported amounts ranged from 1.1 inch (28.0 mm) at Hay Springs to 7.4 inches (188 mm) at Meadow Grove. At most sites, the largest amounts of precipitation fell between May 8 and May 18. Severe thunderstorms with damaging winds and hail struck numerous areas of the state during June. Precipitation amounts were slightly below to below normal in all divisions during June. Total precipitation for July differed greatly from site to site. Most of the rainfall occurred during thunderstorms, which were spotty in nature. All divisions reported normal to above-normal precipitation during July. August precipitation totals were less in most divisions. Several weather sites reported precipitation of 4 to 6 inches (102 to 152 mm). These amounts raised some divisional averages for August. September was very dry in the East Central, Southwest, South Central, and Southeast divisions.

An intense storm entered the western part of the state on October 29 and moved across most of Nebraska. Snowfalls of 5 to 10 inches (127 to 255 mm) were reported in the Panhandle, North Central, and Central divisions. Eastern areas of the state received rain mixed with snow. One of the worst November storms of record moved into western Nebraska on November 19. As the storm moved across the state, blizzard conditions existed at times in the west. Snowfalls of 10 to 25 inches (255 to 640 mm) were reported in the western and north-central areas of state. Most of the precipitation to the east fell as rain mixed with snow. December was mild and very dry in Nebraska. Only small amounts of snow were reported on the ground at month's end.

Almost all recharge to aquifers in Nebraska comes from precipitation that infiltrates into the ground at or near the point where it falls. In some localities, however, seepage from streams, lakes, irrigation canals, and applied irrigation water may be a larger source of recharge. No precise quantitative relationship between precipitation amounts and resultant changes in groundwater levels in the state has been determined, but a rough correlation between water-level fluctuations and precipitation can often be noted in the records. Precipitation amounts can also affect water levels indirectly, because quantities of groundwater pumped for irrigation and municipal use generally are less during wet periods and greater during dry periods.

Summary of monthly, seasonal, and total precipitation in 1979 for eight National Weather Service divisions of Nebraska showing average precipitation amounts in inches, departure (+ or −) from normal precipitation in inches, and the percentage of normal precipitation

GROUNDWATER USE

Distribution of Irrigation Wells

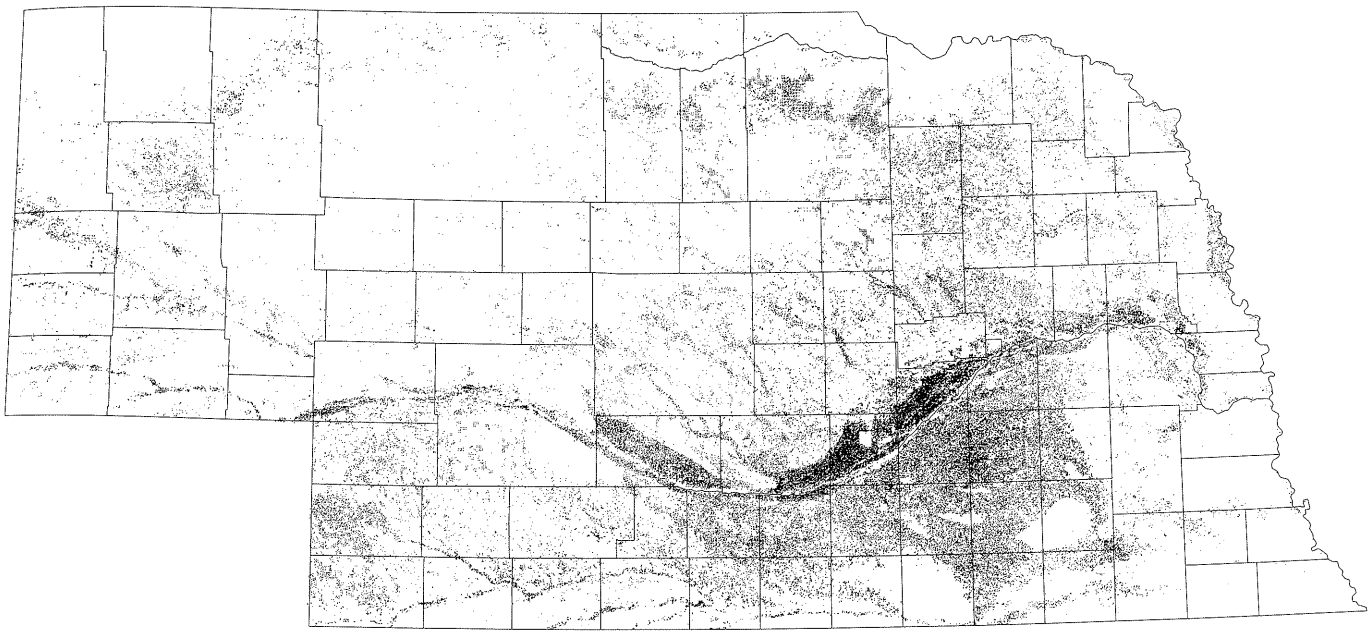
Nebraska's largest use of groundwater during 1979 was that pumped by the state's 63,777 registered irrigation wells.

At the end of 1979, 63,777 irrigation wells had been registered in Nebraska. These wells are the source of water used in irrigating almost 85 percent of the estimated 7.5 million acres (30 500 km^2) of irrigated land in the state. The amount of groundwater pumped for irrigation each year has not been determined, but it is estimated that about 6 million acre-feet (7.4 km^3) were pumped in 1976. This amount is several times more than the total amount of groundwater pumped for domestic, livestock, municipal, and industrial use.

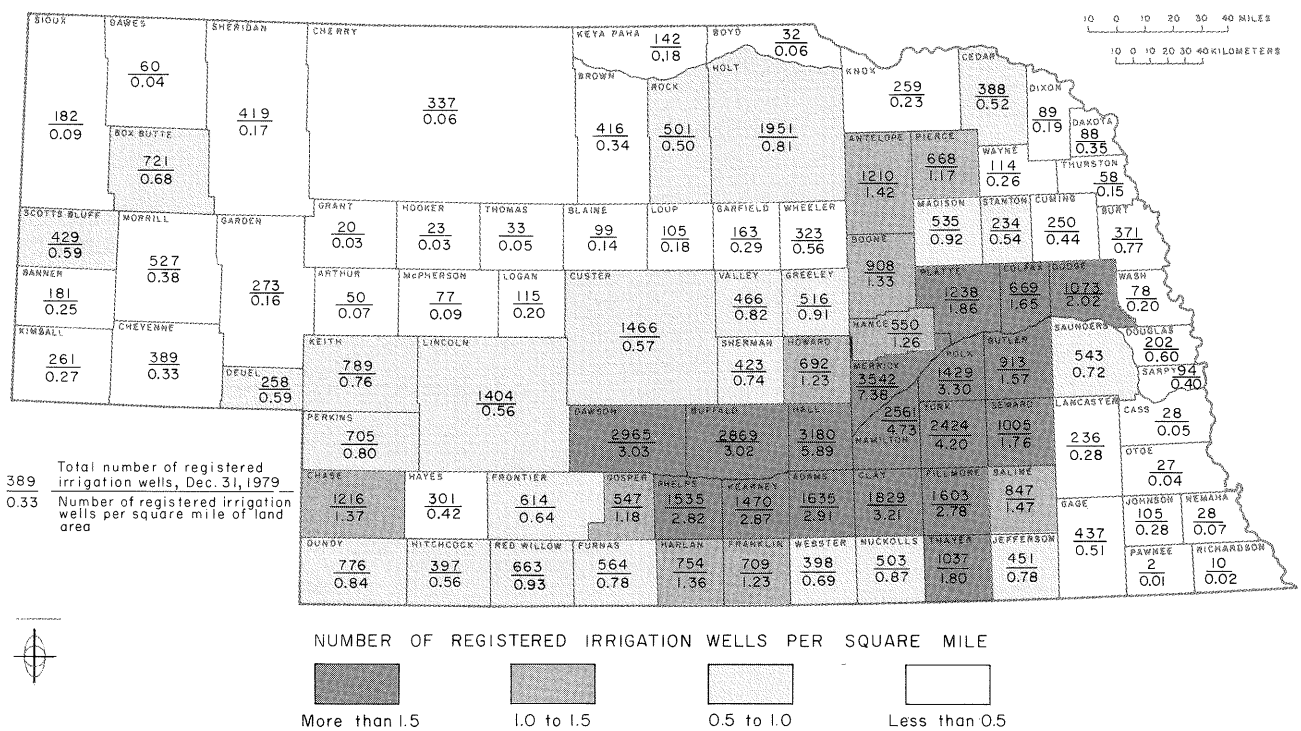
Although irrigation wells have been drilled in each of Nebraska's 93 counties, their number and density differ greatly from one county to another because of variations in land use, distribution of irrigable land, and availability of groundwater. About 60 percent of the registered irrigation wells are concentrated in a 12-county area comprising the upper part of the Big Blue River and Little Blue River basins and the central part of the Platte River valley. Buffalo, Dawson, Hall, Hamilton, Merrick, and York counties have more than 2,300 irrigation wells each and the remaining counties (Adams, Clay, Fillmore, Kearney, Phelps, and Polk) have more than 1,400 irrigation wells each. Antelope, Chase, Custer, Dodge, Holt, Lincoln, Platte, Seward, and Thayer counties are the only other counties in the state that have more than 1,000 irrigation wells each.

Although the total number of irrigation wells in a given county provides some indication of the amount of groundwater development that has taken place, the number of irrigation wells per square mile (2.59 km^2) of land area in that county is a better index of the degree of development. A high density of irrigation wells in a county generally indicates both a large percentage of irrigable land and large amounts of available groundwater. Very low densities generally characterize counties where development is limited either by small amounts of irrigable land or by aquifers that yield only small amounts of water to wells, or both. Merrick County, averaging 7.38 irrigation wells per square mile (2.85/km^2) of land area, has the highest well density of any county in the state. Pawnee County, which has only two irrigation wells in its 433 square miles (1 120 km^2) of land area, has the lowest well density—an average of about one well per 217 square miles (one well per 560 km^2).

By far the largest use of groundwater in Nebraska is for irrigation, and most of the concern about changes in water levels and availability of groundwater is related to irrigation development. However, use of groundwater for rural domestic, livestock, industrial, and municipal supplies is also quite important. Groundwater is used for almost all rural domestic supplies; for all industrial supplies, except some sugar beet processing; and for all municipal supplies, except for Crawford, Beaver Lake, and part of Omaha's supply.



Location of registered irrigation wells in Nebraska as of December 31, 1979



Total number and density of registered irrigation wells in Nebraska, by counties, as of December 31, 1979

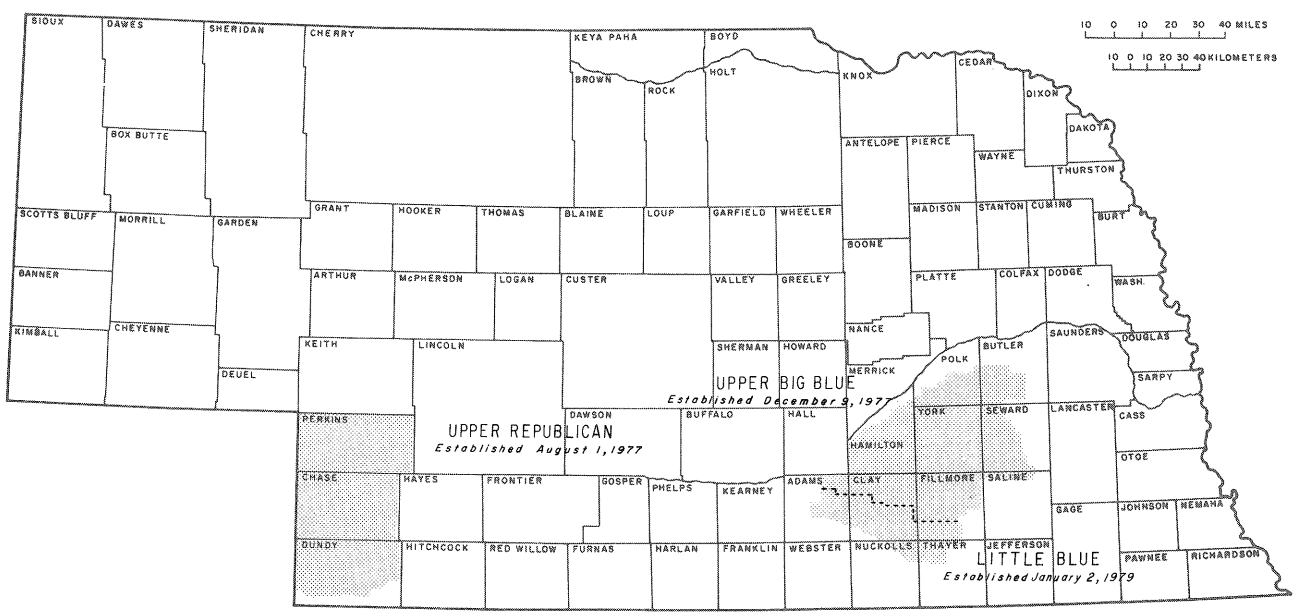
Recent Trends in Groundwater Use

The number of new irrigation wells installed in 1979 was slightly more than for 1978 but was still about half the average for either the last 5-year or 10-year-period. New irrigation wells were reported installed in 83 of Nebraska's 93 counties. More wells were installed during 1979 than in 1978 in 40 of these counties.

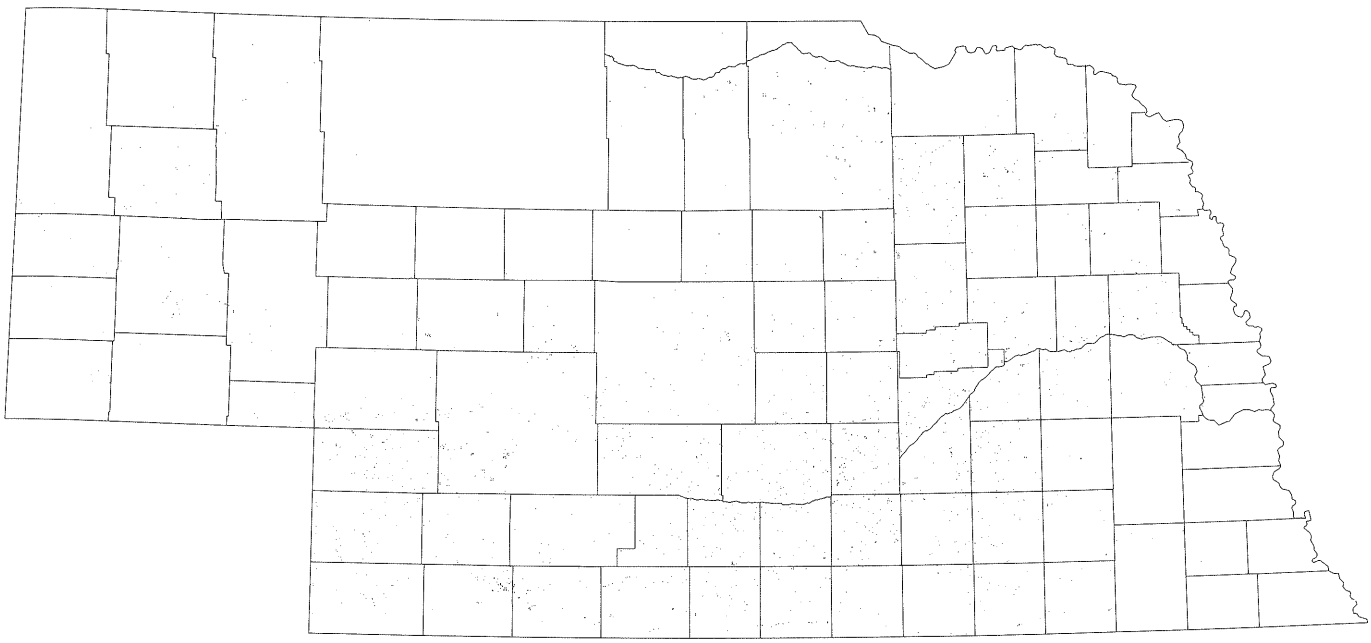
The decrease in the number of irrigation wells installed during 1978 and 1979 compared to the mid-1970s can be explained in part by a combination of economic and climatic factors. Low prices for farm products coupled with the increasing cost of installing and operating irrigation systems discouraged farmers from investing in new well construction. Normal to above-normal precipitation for the state in 1978 and 1979 further reduced the need for additional irrigation development.

The establishment of groundwater control areas was provided for in the Nebraska Ground Water Management Act of 1975 (LB 577). The management alternatives provided by the act include well spacing, rotation of pumping, allocation of water, and moratoriums on drilling.

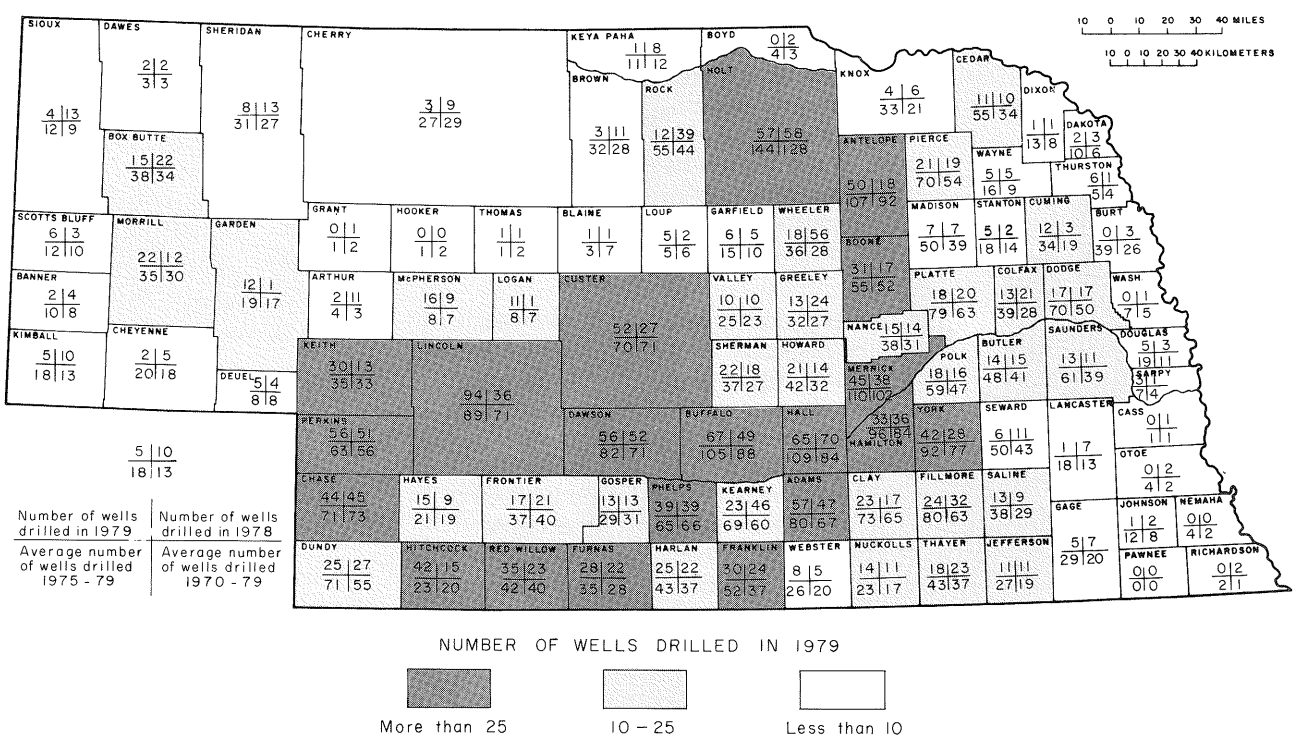
Two control areas were designated in 1977 in response to the initiatives of the Upper Republican Natural Resources District and the Upper Big Blue Natural Resources District. A third control area was designated in 1979 in response to the initiatives of the Little Blue Natural Resources District. It is too soon to assess the effects on groundwater use of the establishment of these control areas.



Location of groundwater control areas



Location of registered irrigation wells drilled in Nebraska in 1979



Number of Nebraska registered irrigation wells drilled in 1979, 1978, 1975-79, and 1970-79, by counties

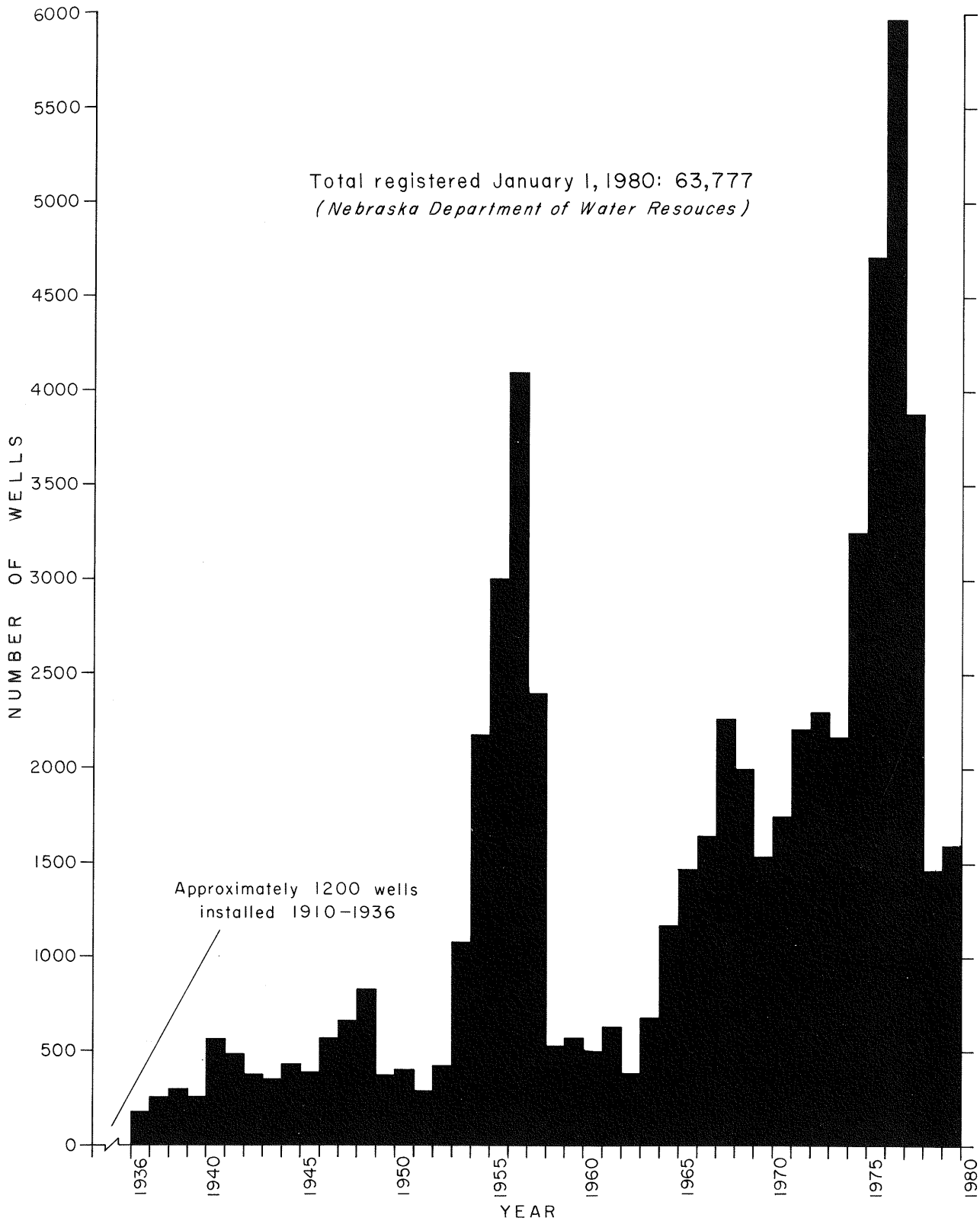
Historical Trends in Groundwater Use

Irrigation has become the most important factor in making Nebraska one of the most agriculturally productive states. During the last two decades, tapping groundwater resources to help meet agricultural demand for water has increased at such a rapid pace that now more than 85 percent of the water used for irrigation is pumped from wells.

Climatic conditions affect the number of new wells installed annually. During periods of below-normal precipitation, such as the growing seasons in the years 1952–56, 1966, and 1974–76, the number of irrigation-well installations increased. The increased drilling often continues for a year or more after the drought period.

Center-pivot irrigation systems have played an important role in expanding irrigation from level land to hilly topography and sandy soils. Generally, the areas of new development are in the northeastern, central, and southwestern parts of the state where center-pivot irrigation systems provide a means to overcome limitations imposed by soil type and/or topography.

A combination of economic, climatic, and technologic factors account for the periods of high development. Drought conditions were primarily responsible for the rapid development of the mid-1950s. Starting in the mid-1960s, development was influenced by periods of drought, the availability of the center-pivot irrigation system, and favorable economic conditions (especially during 1973, 1974, and 1975).



ANNUAL INSTALLATION OF IRRIGATION WELLS IN NEBRASKA THROUGH 1979
(ESTIMATED FROM HISTORICAL SURVEYS AND IRRIGATION WELL REGISTRATION DATA)

Other reports give additional information about water levels in Nebraska

REPORTS CONTAINING WATER-LEVEL INFORMATION

Keech, C. F., and Case, R. L. 1954. Water levels prior to January 1, 1954, in observation wells in Nebraska. U.S. Geological Survey open-file report, pts. 1 and 2. 543 pp.

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Keech, C. F. 1956. Water levels in observation wells in Nebraska during 1955. U.S. Geological Survey open-file report. 106 pp.

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Keech, C. F., and Hyland, J. B. 1962. Water levels in observation wells in Nebraska during 1961. Conservation and Survey Divison, University of Nebraska: Nebraska Water Survey Paper 12. 164 pp.

Emery, P. A., and Malhoit, M. M. 1963. Water levels in observation wells in Nebraska, 1962. Conservation and Survey Division, University of Nebraska: Nebraska Water Survey Paper 13. 157 pp.

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Keech, C. F., and Svoboda, G. R. 1969. Water levels in observation wells in Nebraska, 1968. Conservation and Survey Division, University of Nebraska: Nebraska Water Survey Paper 24. 69 pp.

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Ellis, M. J., and Pederson, D. T. 1976. Groundwater levels in Nebraska, 1975. Conservation and Survey Division, University of Nebraska: Nebraska Water Survey Paper 43. 92 pp.

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———. 1978. Groundwater levels in Nebraska, 1977. Conservation and Survey Division, University of Nebraska: Nebraska Water Survey Paper 45. 96 pp.

Pederson, D.T., and Johnson, M.S. 1979. Groundwater levels in Nebraska, 1978. Conservation and Survey Division, University of Nebraska: Nebraska Water Survey Paper 49. 116 pp.